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ILLUSTRATED KEY

TO THE

TREMATODE PARASITES OF MAN.

BY

CH. WARDELL STILES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

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ILLUSTRATED KEY TO THE TREMATODE PARASITES OF MAN.

By Ch. Wardell Stiles, Ph. D., Chief of Division of Zoology, Hygienic Laboratory, United States Public Health and Marine-Hospital Service.

INTRODUCTION.

Upon several recent occasions the writer has been called upon for information in regard to the trematodes which are parasitic in man, and it is in response to such requests that the present paper is published. This key is offered not as an exhaustive treatment of the subject, but as a ready reference aid in clinical diagnosis.

To the American physician the trematodes or flukes have been heretofore chiefly matters of scientific interest, most men looking upon them as zoological curiosities. Hepatic distomatosis, caused by *Fasciola hepatica* and *F. magna*, is known to occur in cattle, particularly in the Southern States; *F. hepatica* is also found in sheep in various parts of the country, and it need not be surprising if isolated cases of infection with this parasite should be found in man. About 20 cases of hepatic distomatosis, caused by *Opisthorchis sinensis*, have already been found in this country, and it is strange that the cases thus far seen are so few in number. Parasitic hemoptysis, caused by *Paragonimus westermanii*, has been found in the United States in dogs, cats, and swine, and one (imported) case in man has recently been recognized in Portland, Oreg. Bilharziosis, caused by *Schistosoma hæmatobium*, has been found in this country upon at least three occasions, and it is also said to occur in Cuba and Porto Rico. Thus, for the American physician, trematode diseases are becoming something more than a mere matter of curiosity, and their importance is increased by the fact that about 120,000 of our troops have been serving in the Asiatic quarter of the globe, or, in other words, in a part of the world where maladies of trematode origin are more common than they are with us. Whether the return of these troops, together with the return of travelers from Asia, will result in making these diseases more or less common in man in the United States can not be definitely prophesied, but the indications are that we shall not entirely escape infection. It is difficult to guard against the introduction of the parasites under consideration, and the question whether they will multiply here depends primarily upon two factors, namely, first, whether there exist in the United States species of snails which can serve as intermediate hosts; and, second, whether these snails actually become infected by persons harboring the parasites. From the fact that snails are necessary for the propagation of at least some of the trematode maladies of man, it is apparent that cases of infection are more likely to occur in rural districts than in cities. In other words, they are more likely to occur in the practice of a class of physicians who as a rule do not use the microscope as an aid in diagnosis and who, therefore, will not recognize the exact nature of the malady.

CLINICAL CLASSIFICATION OF TREMATODE INFECTIONS (DISTOMATOSIS).

Trematode infection is usually spoken of as *distomatosis*. The name is derived from *Distoma*, which has been used by many authors to designate a collective genus in the family Fasciolidæ. As a generic name, *Distoma* is now suppressed, its species having been distributed in a large number of well-defined genera, but the term *distomatosis* may be conveniently retained (at least until the zoologic nomenclature becomes more settled) to designate infection by digenetic trematodes.

Distomatosis may affect different parts of the human body, as follows:

Ophthalmic distomatosis: Very rare; diagnosis only by ophthalmoscopic examination, or after operation, or on autopsy; treatment surgical; caused by *Monostomulum* (p. 12), and *Agamodistomum* (p. 12).

Cerebral distomatosis (Jacksonian epilepsy): Usually in connection with pulmonary distomatosis; diagnosis symptomatic and by microscopic examination of sputum; no specific treatment; caused by *Paragonimus* (p. 14).

Pulmonary distomatosis (parasitic hemoptysis): Diagnosis by microscopic examination of sputum; no specific treatment; caused by *Paragonimus* (p. 14) and *Fasciola* (p. 18).

Hepatic distomatosis: Diagnosis by microscopic examination of feces; no specific treatment; caused by *Fasciola*, *Dicrocœlium*, and *Opisthorchis* (p. 20).

Pancreatic distomatosis: Occasionally occurs with hepatic infection; caused by *Opisthorchis* (p. 30).

Intestinal distomatosis: Diagnosis by microscopic examination of feces; treatment with thymol, or same anthelmintics as for tapeworms; caused by *Fasciolopsis*, *Heterophyes*, and *Gastrodiscus* (p. 39).

Venal distomatosis (bilharzian hematuria): Diagnosis, microscopic examination of urine and feces; treatment, male fern (?); caused by *Schistosoma* (p. 49).

CLINICAL DIAGNOSIS.

The clinical diagnosis of distomatosis should be made by microscopic examination of the sputum, urine, and feces. No special technique is required. Examine the fresh unstained excretions under a medium power and later under a higher power dry lens. It will not always be possible to determine from the microscopic examination alone whether the infection is hepatic or intestinal, as the size of the eggs varies and the exact species can not always be definitely determined from the egg.

KEY TO THE EGGS OF TREMATODES REPORTED FOR MAN.

(For species thus far found in the United States, follow Roman type.)

1. Eggs in sputum; embryo not developed. Parasitic hemoptysis 2
Eggs in feces; embryo developed or undeveloped 3
Eggs in urine; 120 μ long by 50 μ broad; provided with a 20 μ long terminal or subterminal spine; contain no embryo when first oviposited, but embryo may develop before egg is discharged from the host. Bilharziosis (Egyptian hematuria) .... *Schistosoma hæmatobium* (p. 50)
2. Egg 68 to 118 μ long by 48 to 60 μ broad. This is the egg usually found in parasitic hemoptysis .... *Paragonimus westermanii* (p. 16)
Egg 150 to 190 μ long by 75 to 90 μ broad. Very rare in man .... *Fasciola gigantica* (p. 19)

EGGS IN FECES.

3. The same egg also in the sputum 1
The same egg may also be in the urine 1
The same egg neither in the sputum nor in the urine 4
4. Egg more than 100 μ long 5
Egg less than 50 μ long 6
5. Egg 130 to 145 μ long by 70 to 90 μ broad; does not contain embryo when discharged in feces. Indicates infection of the liver .... *Fasciola hepatica* (p. 22)
Egg 120 to 130 μ long by 77 μ broad; does not contain embryo when discharged in the feces. Indicates infection of the intestine .... *Fasciolopsis buskii* (p. 41)
Egg 150 μ long by 80 μ broad. Indicates infection of the intestine .... *Fasciolopsis rathouisi* (p. 42)
Egg 150 μ long by 72 μ broad. Indicates infection of the intestine .... *Gastrodiscus hominis* (p. 46)
6. Egg contains embryo 7
Not stated whether egg contains embryo; egg 34 μ long by 19 to 21 μ broad. Indicates infection of the liver .... *Opisthorchis noverca* (p. 33)
7. *Embryo with two dark spots in posterior half; egg dark, 38 to 45 μ long by 22 to 30 μ broad. Indicates infection of the liver* .... *Dicrocœlium lanceatum* (p. 29)
Embryo without said spots 8
8. *Egg 26 to 30 μ long by 11 to 15 μ broad. Indicates infection of the liver* .... *Opisthorchis felineus* (p. 31)
Egg 28 to 30 μ long by 16 to 17 μ broad. Indicates infection of the liver .... *Opisthorchis sinensis* (p. 35)
Egg 20 to 30 μ long by 15 to 17 μ broad. Indicates infection of the intestine .... *Heterophyes heterophyes* (p. 45)

THE PARASITES OF DISTOMATOSIS.

Except in cases of intestinal distomatosis and occasionally in hepatic infection, the physician will rarely, if ever, see the parasite during the life of his patient. If trematodes are found on autopsy, they may be determined by use of the key given on p. 11.

ANATOMICAL STRUCTURE OF TREMATODES.

The following technical description shows the systematic position and general structure of the flukes under discussion:

> [Suborder Malacocotylea: Digenea. Families Monostomidæ, Fasciolidæ, Paramphistomidæ, and Schistosomidæ. See figs. 13–15, 18, 20, 42–47, 49–50, 64, 67–68, 78, 85–86.]

With the exception of the blood flukes (*Schistosoma*) they are all hermaphrodites. They are flat, cylindrical, or conical worms, always longer than broad; on the anterior extremity is situated the mouth, surrounded by a muscular organ, known as the *oral sucker* and curved slightly ventrad. There is a second sucker (the *acetabulum*), which is situated in the ventro-median line; in the Fasciolidæ the acetabulum is generally found on the anterior half of the body, while in the family Paramphistomidæ it is at or near the posterior extremity. The surface of the worms is generally more or less covered with minute spines or tubercles.

The *digestive tract* consists of the mouth, a short esophagus, and two blind sacs (intestinal ceca), which represent the true intestine. The anterior portion of the esophagus is generally connected with the mouth by a muscular bulb (the *pharynx*); the posterior extremity bifurcates, one branch being connected with each intestinal cecum. The intestinal sacs are usually simple elongated tubes (fig. 43), but in the genus *Fasciola* they branch freely (fig. 20, *i*). In *Schistosoma* the two ceca unite after passing the genital glands. An anus is never present.

Genital organs.—The *genital pore* is in the ventro-median line in nearly all species here described, the male copulatory organ (*cirrus*, or penis,) lying very close to the female opening (*vulva*). *Male organs:* A cirrus is frequently seen extruded from the genital pore, and in these cases it appears as a curved organ, varying in size according to the species; usually the cirrus is invaginated into the *cirrus pouch*. Through its center runs a canal (the *ductus ejaculatoris*), which receives the spermatozoa from a *vesicula seminalis*. The latter is partially or entirely included in the pouch; at its posterior end it receives either directly or indirectly the two *vasa efferentia*, through which the spermatozoa are conducted from the testicles. The testicles, generally two in number, one right and one left, are more or less round, lobate, or branched. *Female organs:* The vulva leads into a canal, the anterior portion of which is known as the *metraterm;* this is continued as the *uterus*, which forms more or less numerous folds in the median portion of the body, and finally leads to the so-called *shell-gland*, which may frequently be seen in fresh specimens (*Fasciola magna* and others) as a round body a short distance posterior of the acetabulum. In the center of the shell-gland is a canal (the *ootype*), in which four canals (*uterus*, *oviduct*, *Laurer's canal*, and *vitelloduct*) come together. The *ovary* in some species is globular, in others lobate, or branched, and connects with the ootype through the *oviduct*. The *Laurer's canal* runs from the ootype dorsad, and opens to the exterior on the dorsal surface. Its function is still doubtful, but homologically it represents the uterus of cestodes. The *vitellogene glands* (vitellaria) are two in number, and are situated laterally of the longitudinal intestinal ceca; they vary in size in different species, are generally quite elongated, and are composed of numerous branches, or acini, much like a bunch of grapes in form, all of which connect with a longitudinal *vitelloduct* (one on each side of the body); these longitudinal ducts are in turn connected by a pair of transverse ducts which unite in the median line, immediately posterior of the shell-gland, to form a common reservoir; this, in turn, empties into the ootype through the short vitelloduct mentioned above. The vitellaria produce yolk cells, which are associated with the true ovum to form the eggs.

Excretory system. At or near the posterior extremity, generally somewhat dorsally, is situated a small pore (*porus excretorius*), which leads into a *median terminal* *vesicle;* this latter gives off longitudinal branches: these in turn give off secondary branches, which ramify through the body, each small branch ending in an excretory cell.

Nervous system.—A set of ganglia is found at each side of the pharynx: these ganglia are connected by a dorsal commissure and give off numerous nerves to various parts of the body. The largest nerves are the two ventral longitudinal nerves which run antero-posteriorly, and can frequently be seen in fresh specimens.

Life history.—See p. 23.

KEY[a] TO THE GENERA OF TREMATODA REPORTED FOR MAN.

(For species parasitic in man and thus far found in the United States, follow roman type.)

1. Two suckers (acetabula) present 2
One sucker (acetabulum) present (Monostomidæ) .... *Monostomulum* (p. 12)
2. Ventral acetabulum on ventral surface of anterior half of body 3
Ventral acetabulum at posterior end of body, terminal or subterminal (Paramphistomidæ) .... *Gastrodiscus* (p. 45)
3. Monecious (hermaphrodites) (Fasciolidæ) 4
Diecious (sexes separated) (Schistosomidæ) .... *Schistosoma* (p. 50)

FASCIOLIDÆ.

4. Mature distomes, or worms developed at least to a stage which permits a determination of the genus 5
Immature distomes, or forms not sufficiently developed to permit a determination of the genus .... *Agamodistomum* (p. 12)
5. Genital pore not surrounded by a circular, muscular, acetabulum-like structure 6
Genital pore postero-lateral of acetabulum and surrounded by a circular, muscular structure which looks like a third acetabulum .... *Heterophyes* (p. 43)
6. Genital pore between oral sucker and acetabulum 7
Genital pore postero-median or postero-lateral of acetabulum .... *Paragonimus* (p. 15)
7. Intestinal ceca dendritic .... *Fasciola* (p. 21)
Intestinal ceca not dendritic 8
8. *Body large, usually over 25 mm. long, and 14 mm. broad; ovary branched; vitellogene glands extend to posterior end of body, caudad of testicles.* *Fasciolopsis* (p. 39)
Body usually less than 20 mm. long, and rarely over 5 mm. broad; ovary not branched; vitellogene glands do not extend caudad of testicles 9
9. *Testicles anterior of ovary and uterine coils* .... *Dicrocœlium* (p. 28)
Testicles posterior of ovary and uterine coils .... *Opisthorchis* (p. 30)

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[a] This key is based primarily upon the species found in man, and on this account should not be relied upon for other species found in other animals.

OPHTHALMIC DISTOMATOSIS.

On only two occasions have trematodes been reported for the human eye, but neither of the parasites is well described. For a full discussion of these cases, with English translations of the original observations, also with bibliography and synonymy, see Stiles (1902, pp. 24–35, pl. 3, figs. 2–5). Cases of similar infection are described for fish.

Family MONOSTOMIDÆ.

Collective group MONOSTOMULUM Brandes, 1892.

Generic diagnosis.—Monostomidae: An artificial collective group to contain agamic monostomes in which the characters are not sufficiently developed to permit of an exact generic determination. Such an artificial group does not have any type species.

The Eye Monostome—MONOSTOMULUM LENTIS[a] (Gescheidt, 1833) Brandes, 1892—of Man.

[No illustrations published.]

Specific diagnosis.—*Monostomulum:* One-tenth of a line (0.22 mm.) long.

Habitat.—In crystalline lens of eye of man (*Homo sapiens*), in Odessa.

Family FASCIOLIDÆ.

Collective group AGAMODISTOMUM[b] Stossich, 1892.

Generic diagnosis.—Fasciolidae: An artificial collective group to contain agamic distomes in which the characters are not sufficiently developed to permit of an exact generic determination. Such an artificial group does not have any type species.

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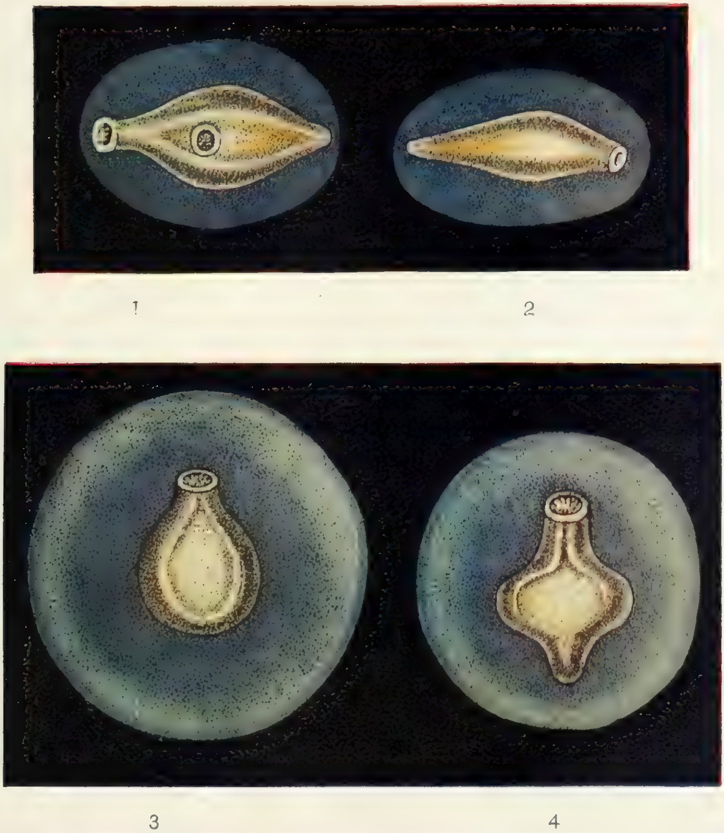
[a] Synonyms.—?*Fasciola hepatica* Linnæus, 1758 [see p. 22]; "Monostomen" Nordmann, 1832; *Monostoma lentis* Gescheidt, 1833; *Monostomum lentis* (Gescheidt, 1833) Diesing, 1850; *Festucaria lentis* (Gescheidt, 1833) Moquin-Tandon, 1860; "*Distoma ophthalmobium* Diesing, 1850" of Cobbold, 1864, in part; *Monostomulum lentis* (Gescheidt, 1833) Brandes, 1892; ?*Agamodistomum ophthalmobium* [see p. —]; ?*Dicrocœlium lanceatum* Stiles & Hassall, 1896 [see p. —].

[b] Synonyms.—*Agamodistomum* Stossich, 1892; *Distomulum* Brandes, 1892; *Agamodistoma* Stossich, 1898.



Haines, del.

DORSAL AND VENTRAL VIEWS OF AGAMODISTOMUM OPHTHALMOBIUM.

FIG. 1. Ventral view of *Agamodistomum ophthalmobium*. (After von Ammon, 1838, pl. 12, fig. 24.)

FIG. 2. "Dorsal" (lateral?) view of same. (After von Ammon, 1838, pl. 12, fig. 25.)

FIGS. 3, 4. Two other views of same in different stages of contraction. (After von Ammon, 1841, pl. 14, figs. 19, 20.)

Note that in fig. 1, published in 1838, a ventral acetabulum is distinct; in figs. 3 and 4, published in 1841, no ventral acetabulum is evident.

The Eye Distome—AGAMODISTOMUM OPHTHALMOBIUM[a] (Diesing, 1850) Stossich, 1892—of Man.

[Figs. 1 to 4.]

SPECIFIC DIAGNOSIS.—*Agamodistomum:* Body ovate-lanceolate, variable, one-fourth to one-half line long, one-sixth of a line broad. Mouth terminal to subterminal, orbicular. Acetabulum one-third larger than oral sucker, subcentral, with circular aperture.

HABITAT.—Between crystalline lens and its capsule, in eye of man (*Homo sapiens*), in Dresden.

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[a] SYNONYMS.—"Distomen" Ammon, 1833; *Distoma oculi humani* Gescheidt, 1833; *Distomum ophthalmobium* Diesing, 1850; *Distoma ophthalmobium* (Diesing, 1850) Küchenmeister, 1855; *Dicrocælium oculi humani* (Gescheidt, 1833) Weinland, 1858; "*Distoma oculare* Nordmann" of Moquin-Tandon, 1860; *Fasciola ocularis* Moquin-Tandon, 1860; *Fasciola oculis* Moquin-Tandon, 1861; *Distoma ocular* de Bonis, 1882; *Agamodistomum ophthalmobium* (Diesing, 1850) Stossich, 1892; ?*Dicrocælium lanceatum* Stiles & Hassall, 1896 [see p. 29]; "*Distom. okuli humani* Ammon" of Schneidemühl, 1896.

PULMONARY DISTOMATOSIS OR PARASITIC HEMOPTYSIS AND CEREBRAL DISTOMATOSIS OR JACKSONIAN (CORTICAL) EPILEPSY.

Pulmonary distomatosis is the primary, cerebral distomatosis the secondary infection, and while it is not excluded that cerebral infection may take place in connection with hepatic or venal infection, still as a matter of fact it has been reported only in Asia, where it occurs in connection with *Paragonimus* infection of the lungs. The parasites are also recorded for the liver, peritoneum, testicles, etc.

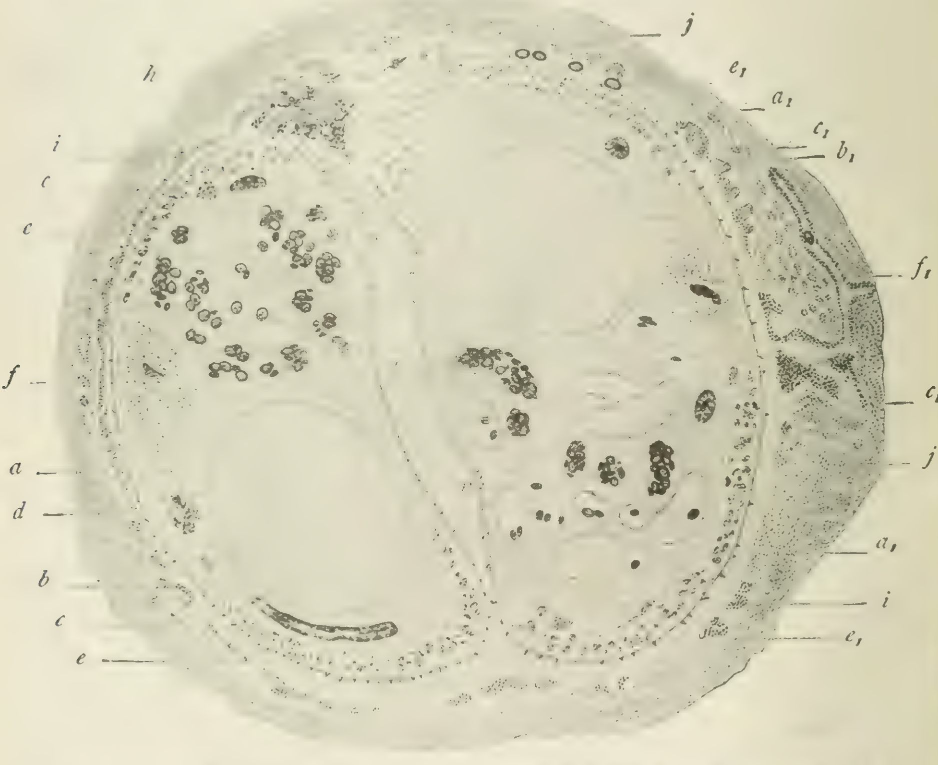
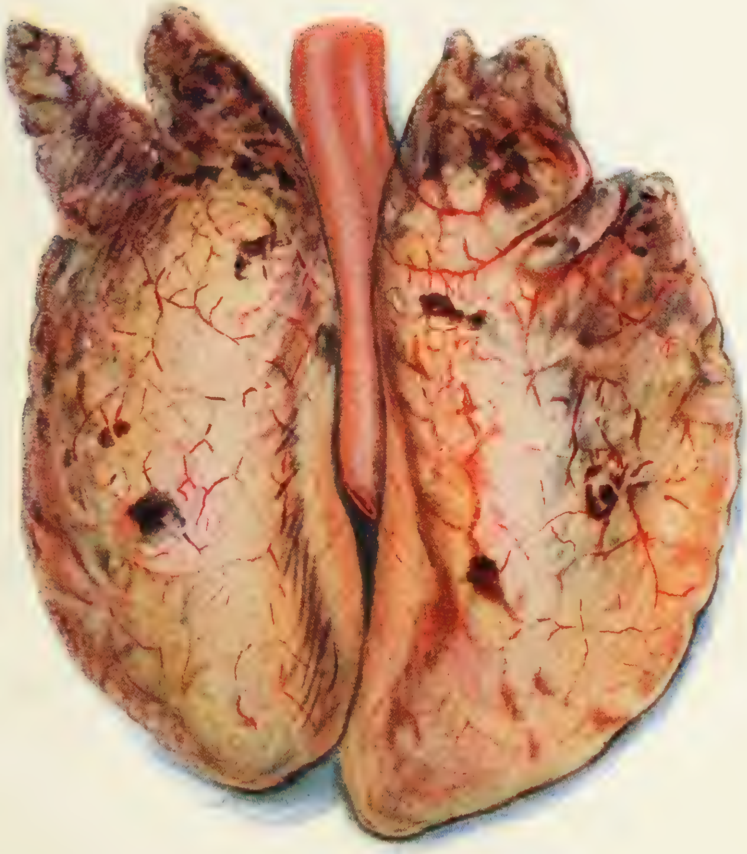


Fig. 9.—Section of a cyst in the lower lobe of a cat's left lung containing two lung flukes. *A*, *B*, cross-sections of the two worms; *a*, *a*, parenchyma of the worms; *b*, *b*, cuticle, with spines; *c*, *c*, intestinal ceca; *d*, a part of the ovary; *e*, vitellaria; *f*, shell gland; *g*, eggs in the uterus; *h*, cyst wall; *i*, flattened epithelial cells forming the lining of the cyst; *j*, schleim glands in the wail of the cyst. × 11. (After Katsurada, 1900, pl. 14, fig. 1.)

Clinical diagnosis.—Examine fresh unstained sputum for eggs (figs. 11–12).

Symptoms.—Cough, spitting of tenacious, rusty, or bloody sputum; in cerebral infection, also epileptic attacks.



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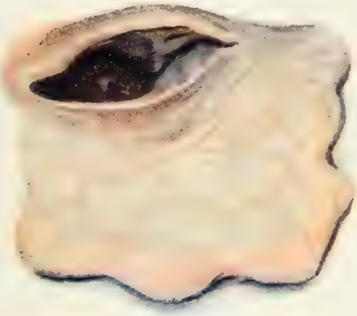
LUNGS OF SWINE INFECTED WITH FLUKES.

FIG. 5. The lungs of a hog, showing the cysts caused by infection with lung lukes (*Paragonimus westermanii*). Reduced. (After Stiles & Hassall, 1900, l. 23.)



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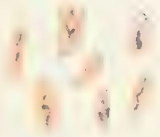

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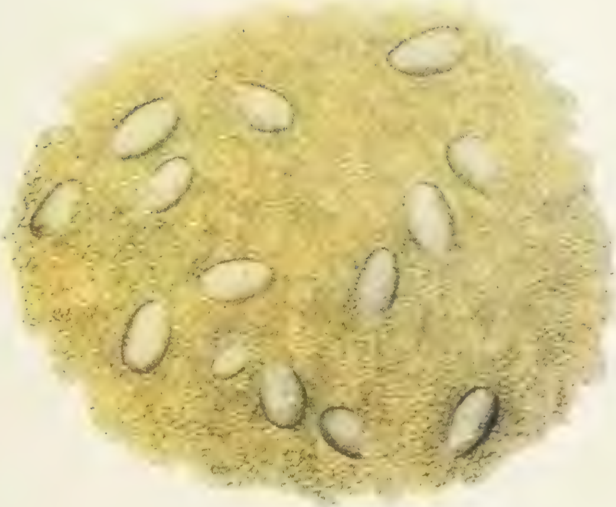

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LUNG FLUKES OF SWINE.

FIG. 6. A portion of hog's lung, containing a lung-fluke cyst, which is here cut open. (After Stiles & Hassall, 1900, pl. 24, fig. 1.)

FIG. 7. Six lung flukes (*Paragonimus westermanii*) from hogs. Drawn from life; slightly reduced; natural color. (After Stiles & Hassall, 1900, pl. 24, fig. 2.)

FIG. 8. Content of a lung-fluke cyst, containing eggs of the lung fluke. Greatly magnified. (After Stiles & Hassall, 1900, pl. 24, fig. 3.)

Treatment.—Send patient to noninfected region, thus preventing reinfection; specific treatment unknown.

For a detailed discussion of this subject, with review of the medical literature, see Stiles & Hassall (1900, pp. 560–611).

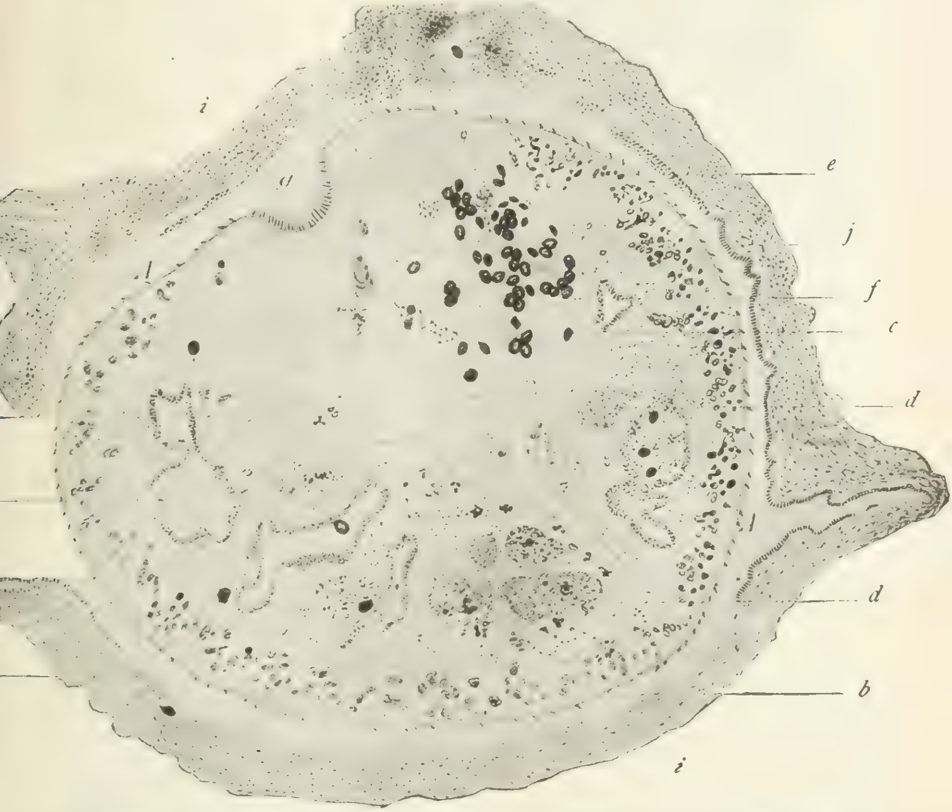

Fig. 10.—Section of a cyst in the lower lobe of the left lung of a man containing a lung fluke. *A*, diagonal section of the worm; *a*, parenchym; *b*, cuticle, with spines; *c*, intestinal ceca; *d*, testicles; *e*, vitellaria; *f*, eggs in the uterus; *g*, ventral acetabulum; *h*, excretory system; *i*, cyst wall; *j*, cylinder epithelium in part ciliated. 12. (After Katsurada, 1900, pl. 14, fig. 2.)

Family FASCIOLIDÆ.

Genus PARAGONIMUS[a] Braun, 1899.

Generic diagnosis.—Fasciolidæ: Body medium large, thick, elongate, frequently oval, and on cross section more or less round, usually somewhat attenuate toward posterior extremity. Cephalic cone wanting. Skin provided with scale-like spines. Acetabulum near equator. Intestine with strong, somewhat elongate pharynx; very short esophagus; intestinal ceca zigzag, extending to caudal end of the body. Median excretory stem (or bladder) large dorso-ventrally, irregular in outline, and extending cephalad to near the pharynx. Genital pore near caudal margin of ventral acetabulum, in median line or to the right or left. Copulatory organs (cirrus) absent. *Male organs:* Testicles round (?), or branched, in posterior half of body, one each side of median line and one slightly posterior of the other. *Female organs:* Ovary somewhat branched, the branches being thick and short, and the organ located postero-lateral of the ventral acetabulum, on the side (right or left) of the median line opposite to the main portion of the uterus; receptaculum seminis absent; Laurer's canal present; vitellaria enormously developed, extending from anterior to posterior end of the body and located (as seen in cross section) on the periphery, usually leaving a longitudinal free space both in the dorsal and ventral median field. The transverse vitelloducts pass cephalad of the testicles, but caudad of ovary and uterus. Uterus may be only slightly developed, or may form a comparatively large-sized rosette more than half as broad as the body; it may be located entirely on one side (right or left) of median line, or may extend both sides of median line, partially covering the ovary. *Eggs* rather large, about 80 to 118 μ long by 48 to 60 μ broad. Embryo develops after oviposition.

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[a] Synonyms.—*Paragonimus* Braun, 1899; *Polysarcus* Looss, 1899 [not Fieb., 1853, orthopteron.]

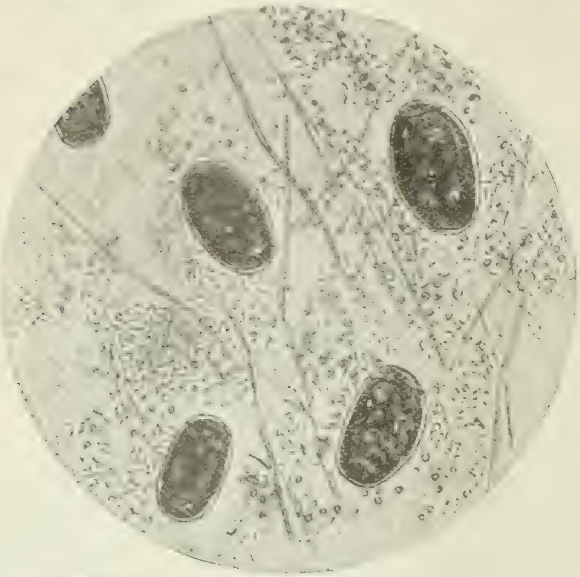

FIG. 11.—Sputum of man containing eggs of the lung flukes, greatly enlarged. (After Manson, 1900, p. 568, fig. 84.)

HABITAT.—Encysted, usually two in each capsule, in lungs of mammals.

TYPE SPECIES.—*Paragonimus westermanii* (Kerbert, 1878).

The Asiatic Lung Fluke—PARAGONIMUS WESTERMANII[a] (Kerbert, 1878) Stiles & Hassall, 1900—of Man.

[Figs. 5 to 16.]

SPECIFIC DIAGNOSIS.—*Paragonimus:* 8 to 16 mm. (after Kellicott 15 to 20 mm.) long, 4 to 8 mm. broad, 2 to 5 mm. thick; plump, pinkish to reddish-brown (alive) or slate (preserved) in color; live specimens are depressed and with variable outline; preserved specimens often oval to elongate pyriform, transverse section round or nearly so, anterior end bluntly rounded, posterior end less blunt. Oral sucker 0.53 to nearly 0.75 mm. (Leuckart) or more (0.864 by 1.017 mm. or 1 to 1.4 mm.)[b] (Ward); or 0.80 to 1.12 by 0.80 to 0.83 mm. (Stiles & Hassall); 0.78 (Kerbert) in

[a] SYNONYMS.—*Distoma westermanii* Kerbert, 1878; *Distoma ringeri* Cobbold, 1880; *Gregarina pulmonum* Baelz, 1880; *Gregarina fusca* Baelz, 1880; *Distomum westermani* Kerbert, 1881; *Distoma pulmonis* Kiyona, Suga, and Yamagate (1881); *Distomum pulmonis* Kiyona, Suga, and Yamagate (1881); *Distoma pulmonale* Baelz, 1883; *Distoma pulmonare* La Clinica de Malaga, 1883; *Distoma pulmonum* (Baelz) Tomono Hidekata, 1883; "*Distoma hepaticum* Linn." of Miura, 1889; *Distomum ringeri* (Cobbold, 1880) von Linstow, 1889; *Distomum westermanni* Leuckart, 1889; *Distomum pulmonale* (Baelz) Leuckart, 1889; *Distomum cerebrale* Yamagiwa, 1890; *Distoma ringers* Rev. Sci., 1890; "*Mesogonimus westermanni* (Kerbert, 1878)" Railliet, 1890; *Mesogonimus pulmonalis* (Baelz, 1883) Railliet, 1890; *Mesogonimus ringeri* (Cobbold, 1880) Railliet, 1890; *Distoma westermani* (Kerbert, 1881) Weber, 1891; "*Distoma westermanni* (Leuckart) Blanchard, 1891; "*Mesogonimus pulmonale* (Baelz, 1878)" Stossich, 1892; "*Distoma* (*Mesogonimus*) *westermanni* Kerbert, 1878," of Stiles, 1894; *Distomum* sp. of Kellicott, 1894; *Distomi ringeri* (Cobbold, 1880) Simon, 1897; *Paragonimus westermanii* (Kerbert, 1878) Stiles & Hassall, 1900.

[b] Suckers distorted, measurements not exact.—Ward.

diameter, terminal or subterminal in different specimens from the same lung. Ventral acetabulum (0.6 to at most 0.75 mm.—Leuckart; 0.78 mm.—Kerbert; 0.75 to 1.017 mm.—Ward; 0.88 to 1.2 by 0.86 to 1.44 mm.—Stiles & Hassall) very slightly larger than oral sucker; situated somewhat anterior of equator of the body, 2 to 4 mm. back of oral sucker. Skin provided with broad scale-like spines.[a] Pharynx elongate; esophagus very short, so that the bifurcation of the intestine is considerably anterior of the ventral acetabulum; intestinal ceca usually somewhat zigzag, some distance from each other, run irregularly to posterior extremity. *Genital pore*, often indistinct, close to the caudal margin of ventral acetabulum, may be in the median line or immediately to the right or left of it. *Male organs:* Cirrus and cirrus pouch absent; ductus ejaculatorius straight; testicles tubular, ramified, one slightly posterior of other, on each side of median line. *Female organs:* Ovary branched, lateral, right or left of median line, somewhat posterior of acetabulum and antero-ventral of transverse vitello-duct; on the opposite side of median line, at about the same height, is situated a lobate shell gland and a rather short, massed uterus; in some specimens the latter may spread across the median line and partially cover the ovary; folds of uterus extend ventrally of shell gland; vitellaria marginal, highly developed, extending from anterior to posterior extremity, often leaving but a small portion of the dorsal and ventral median field uncovered; transverse vitello-ducts dorsal; vitelline reservoir large; Laurer's canal present. *Eggs* oval, 80 to 100 μ

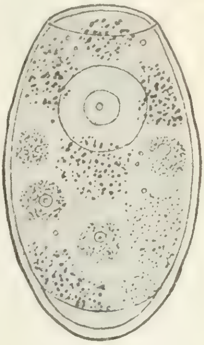

FIG. 12.—Egg of the lung fluke showing the ovic cell and a number of vitelline or yelk cells. Note also the cap or operculum. × 1,000. (After Katsurada, 1900, p. 507, fig. 3.)

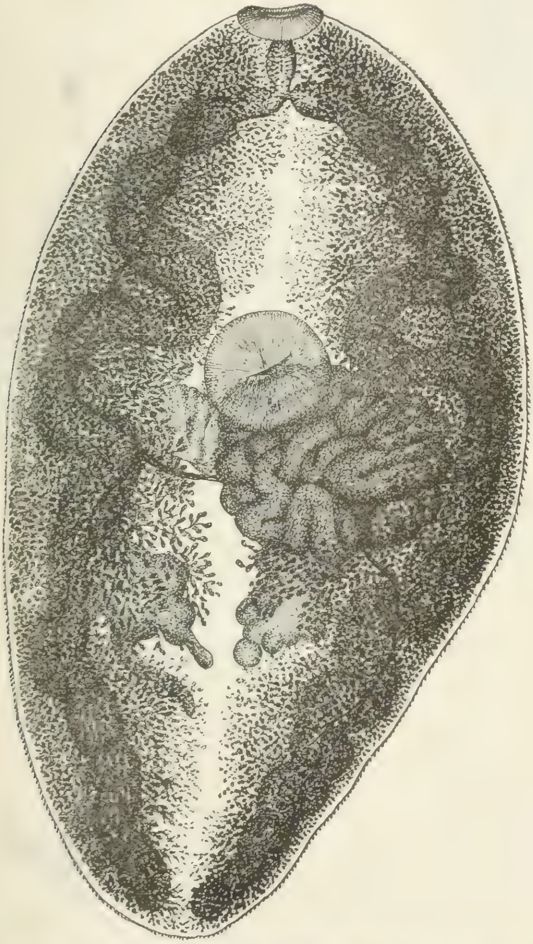

FIG. 13.—Ventral view of a compressed specimen of a lung fluke from a hog. Greatly enlarged. (After Stiles & Hassall, 1900, p. 563, fig. 24.)

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[a] Largest in the middle of the body, after Leuckart, but largest on anterior portion, after Kerbert; smallest around mouth, after Stiles & Hassall.

long by 56 μ broad (Leuckart); 96 to 118 μ long by 48 to 53 μ broad (Ward); 68 to 96 μ long by 48 to 60 μ broad (Stiles & Hassall); yellow shell. Miracidium ciliated, develops after eggs leave the host. Sporocyst, redia, cercaria, and intermediate host undetermined.

Habitat.—Lungs and brain (occasionally in other parts of the body), royal tiger (*Felis tigris*), domesticated cat (*Felis catus domestica*), domesticated dog (*Canis familiaris*), swine (*Sus scrofa domestica*), and man (*Homo sapiens*).

Geographic distribution.—China, Japan, Formosa, occasional imported cases in Europe, some cases of endemic infection in the United States.

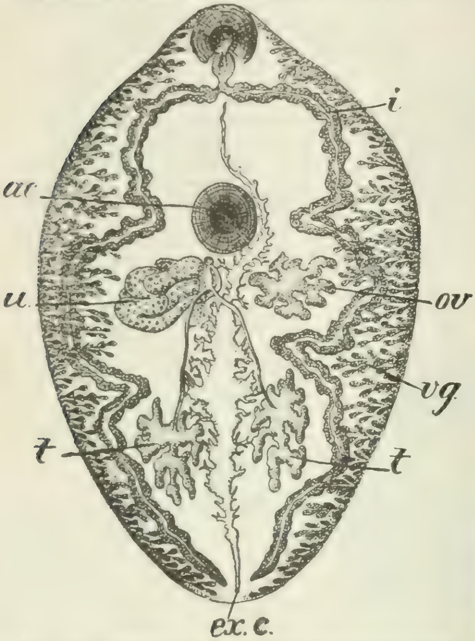

Fig. 14.—Ventral view of a lung fluke from man showing anatomy: *ac*, acetabulum; *ex. c*, excretory canal; *i*, intestinal ceca; *ov*, ovary; *t*, testicles. (After Leuckart, 1889, p. 405, fig. 182.)

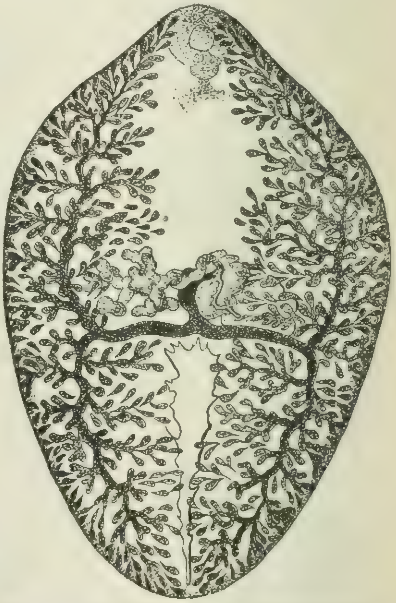

Fig. 15.—Dorsal view of a lung fluke from man showing ovary, shell gland, vitellaria, and Laurer's canal. (After Leuckart, 1889, p. 186, fig. 428.)

From the medical point of view this is one of the most important flukes, but from the agricultural standpoint it is less important than *Fasciola hepatica* (see p. 22). Thus far the Asiatic lung fluke has been reported for this country for the cat (at Ann Arbor, Mich.), the dog (at Columbus, Ohio), and the domesticated hog (at the abattoirs in Cincinnati, Ohio). One (imported) case in man has recently been found in Portland, Oreg. It should be held in mind in connection with American troops who return from service in the Philippines.

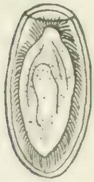

Fig. 16.—Egg of the lung fluke from man containing a ciliated embryo, and showing the cap or operculum at one end. (After Nakahama, 1883.)

Genus FASCIOLA Linnæus, 1758.

For diagnosis, see p. 21.

Although pulmonary distomatosis is usually caused by flukes of the genus *Paragonimus*, it occasionally happens that the liver flukes (genus *Fasciola*) are found in the lungs of various animals. One case of such infection in man has been reported. The species in question was—

The Giant Liver Fluke—FASCIOLA GIGANTICA[a] Cobbold, 1856—of Giraffes, Cattle, Sheep, Goats, and Man.

[Figs. 17 to 18.]

FIG. 17.—The Giant Liver Fluke *Fasciola gigantica* [*F. hepatica ægyptiaca*]), drawn from one of Looss's specimens, natural size. (After Stiles, 1898, p. 49, fig. 25.)

SPECIFIC DIAGNOSIS.—*Fasciola:* 25 to 75 mm. long by 3 to 12 mm. broad, flat, oblong, lanceolate; anterior end cylindrical, attenuate; sides nearly parallel for greater part of length, especially of the anterior half; posterior end obtuse. Oral sucker 1.12 mm. in diameter; ventral acetabulum somewhat larger. Skin with spines. Pharynx, —?—; esophagus extends nearly to acetabulum; intestinal ceca more profusely branched than in *F. hepatica.* Genital pore median, about halfway between mouth and acetabulum. *Male organs:* Similar to those of *F. hepatica*, but the testicles are more profusely and delicately branched and do not extend so far caudad. *Female organs:* In general similar to those of *F. hepatica*, but more profusely and delicately branched. *Eggs*, 150 to 190 μ long by 75 to 90 μ broad. Sporocyst, redia, cercaria and intermediate host undetermined.

HABITAT.—Liver of giraffe (*Giraffa camelopardalis*), cattle (*Bos taurus*), zebu (*Bos indicus*), buffalo (*Bos bubalis*), sheep (*Ovis aries*), goats (*Capra hircus*), in Africa. One case reported for lungs of man (*Homo sapiens*).

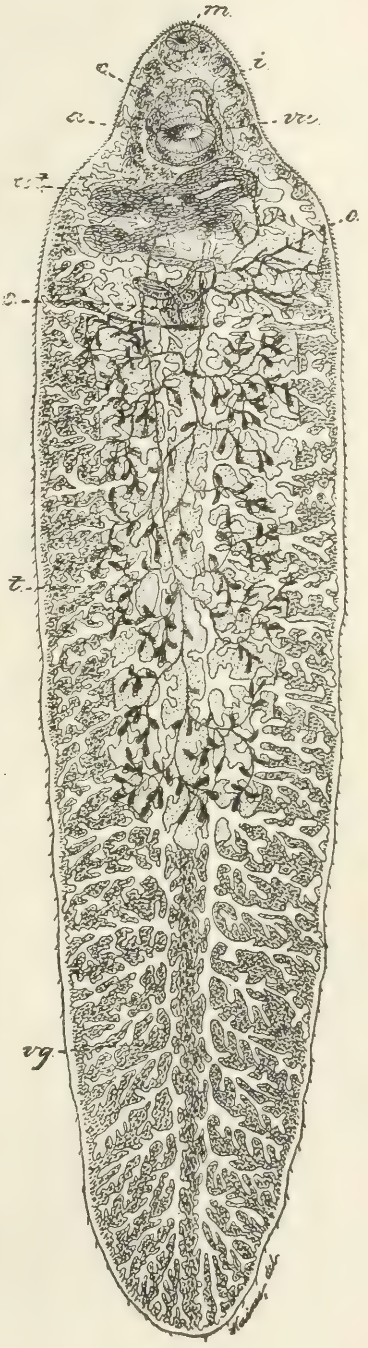

FIG. 18.—The Giant Liver Fluke (*Fasciola gigantica* [*F. hepatica ægyptiaca*]), enlarged to show the anatomic characters: *ac*, acetabulum; *c. p.*, cirrus pouch; *i*, intestinal ceca; *m*, mouth, with oral sucker; *ov*, ovary; *s. g.*, shell gland; *t*, profusely branched testicles; *ut*, uterus; *va*, vagina; *v. g.*, profusely branched vitellogene glands. (After Looss, 1896, pl. 3, fig. 16.)

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[a] VERNACULAR NAMES.—The giant liver fluke; the narrow liver fluke; the Egyptian liver fluke.

SYNONYMS.—*Fasciola gigantica* Cobbold, 1856; *Distomum giganteum* Diesing, 1858; *Distoma hepaticum* (in part) of Gervais & van Beneden, 1859; *Fasciola gigantea* (Diesing) Cobbold, 1858; *Cladocœlium giganteum* (Diesing) Stossich, 1892, in part; *Fasciola hepatica angusta* Railliet, 1895; *Fasciola hepatica ægyptiaca* Looss, 1896; *Fasciola angusta.*

BIBLIOGRAPHY.—For bibliography and technical discussion, see Stiles (1895, pp. 139-143); Looss (1902, pp. 782-783).

HEPATIC DISTOMATOSIS.

At least five species of parasites have been reported in connection with hepatic distomatosis in man; all are members of the family Fasciolidae.

CLINICAL DIAGNOSIS. Make microscopic examination of fresh, unstained feces for eggs; also, examine sputum and urine for eggs, as the ova in pulmonary and venal distomatosis may be discharged per anum; hence, finding eggs in feces without excluding distomatosis of lungs and veins may lead to error in diagnosis (see pp. 14, 49).

SYMPTOMS. Best studied for epizootic distomatosis caused by *Fasciola hepatica* in sheep: (1) Period of traumatic inflammation of liver, symptoms may be indefinite, no eggs in feces; (2) period of anemia, positive diagnosis may be made by finding characteristic eggs in feces; (3) period of emaciation, atrophy of liver; (4) period of emigration of flukes. For more detailed discussion in English, see Stiles (1898, pp. 29–57).

Taylor (1884, pp. 48–57) gives the following symptoms for infection of man with *Opisthorchis sinensis*:

> The dwellers in these villages are attacked irrespective of age, sex, or physical condition. Young children are among the sufferers. When one in a family is found infected, several members of the family generally present the same symptoms in a greater or less degree. In this respect this disease offers a contrast to Endemic Hæmoptysis. A very large ratio of the inhabitants of the villages mentioned are victims of the parasite. Some native practitioners place the estimate at 1 in every 7, while others make it as high as 1 in every 5 of the whole population.
>
> *Symptoms and course.*—One of the first and most prominent symptoms is the enlargement of the liver, followed, attended, or preceded by diarrhoea. At first the diarrhoea is irregular and intermittent, the attacks gradually become more frequent and lasting longer, till, after a period of from 2 to 5 years, there may be hardly any interval between them. The stools, which may or may not be dark and bloody, sometimes reach 12 in a day. In some cases bloody diarrhoea becomes after a time almost constant, while in others blood appears in the stools only at irregular intervals. The liver continues to increase in size, though at times it apparently diminishes temporarily. There may be occasional tenderness over the hepatic region, or more or less constant pain. Jaundice, sometimes intermittent, is a frequent symptom. There is generally a dark ashen discoloration of the skin. The temperature varies between 99° and 100.5° F., or may remain normal. The pulse, though generally about normal, frequently rises to 85° or 100°. After a time anasarca, likewise intermittent, appears and affects the legs especially. Ascites is also very likely to

occur, increase for a time, and then gradually diminish, to appear again and again. The patient is reduced by diarrhoea, becomes emaciated, and grows anæmic and weak, but the appetite is usually preserved. Thus it happens that the victims of this disease are frequently reduced so low that their life is dispared of, yet they gradually recover and become apparently almost well. By and by, however, relapse occurs, and the same process is repeated again and again, ground being lost on each occasion, until at length, worn out by exhaustion, the patient after many years of illness dies. Whether any fully recover is not stated, or whether a change of locality is attended by continuous convalescence is not yet known. Recovery after becoming the victim of *Distoma hepaticum* [*O. sinensis*] must at best be problematic. When in an affected locality a case of enlargement of the liver and diarrhoea presents itself, careful examination of the feces is generally rewarded by finding the ova of the *Distoma*.

Many of these patients are troubled with skin diseases, but being of a poor class and living in a more or less filthy condition the skin disease may have no connection with the diseased liver.

TREATMENT. No specific treatment; remove patient to noninfected area, or if kept at home avoid further infection and give nourishing food. Salol has recently been reported as effective in liver-fluke disease in sheep, but the results obtained are not yet published in sufficient detail to permit of a satisfactory opinion.

Family FASCIOLIDÆ.

Genus FASCIOLA[a] Linnæus, 1758.

GENERIC DIAGNOSIS.—Fasciolidæ: Body quite large, broad, and flat; the anterior portion differentiated into a conical cephalic cone, and usually quite well defined from the broader, flatter, leaf-like portion. Skin provided with strong spines. Acetabulum near base of cephalic cone, and of about the same size as the oral sucker. Intestine with well-developed pharynx, short esophagus, and long intestinal ceca; the latter extend to the extreme aboral pole of the body, and are provided with numerous long lateral and fewer and shorter median branches; these branches may branch secondarily. Excretory system highly developed. *Genital pore* median at base of cephalic cone, and anterior of ventral acetabulum. Copulatory organs present, genital glands about in the middle of the body. *Male organs:* Testicles side by side or one diagonally posterior of the other, both caudad of the ovary and transverse vitelloduct, and profusely branched. *Female organs:* Ovary lateral of median line, anterior of transverse vitelloduct, posterior of acetabulum, profusely branched. Receptaculum seminis absent; Laurer's canal present. Vitellaria very profusely developed, extending from base of cephalic cone to extreme aboral pole, and occupying nearly the entire posterior portion of body, especially the margins except the portion occupied by the testicles, ovary, and uterus; uterine coils form a rosette between testicles and acetabulum. *Eggs* not especially numerous, but large, with development after oviposition.

HABITAT.—Liver of mammals, especially herbivorous animals.

TYPE SPECIES.—*Fasciola hepatica* Linnæus, 1758, of ruminants.

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[a] SYNONYMS.—*Fasciola* Linnæus, 1758; *Planaria* Gœze, 1782 (not Mueller, 1776); *Distoma* Retzius, 1782 (not Savigny, 1816); *Distoma* (*Cladocalium*) Dujardin, 1845; *Fasciolaria* Anonymous, 1845; *Distomum* Diesing, 1850; *Cladocalium* Pontallié, 1853; *Distomum* (*Fasciola*) Leuckart, 1863; *Cladocalium* (Dujardin) Stossich, 1892; *Phasciola* Wilder, 1894.

The Common Liver Fluke—FASCIOLA HEPATICA[a] Linnæus, 1758—of Ruminants, Man, etc.

[Figs. 19 to 38.]

Specific diagnosis.—*Fasciola:* 18 to 51 mm. long, 4 to 13 mm. broad; pale brown to slate in color; the anterior 3 to 5 mm. forms a rather thick conical portion which is more or less distinctly defined from the broad, flat, leaf-like body of elongate-oval form; this latter widens rapidly to the maximum breadth, then decreases gradually in width to the posterior end, which is bluntly pointed. Oral sucker about 1 mm. in diameter, round, terminal, but inclines ventrad. Ventral acetabulum about 1.6 mm. in diameter, situated about 3 to 4 mm. caudad of oral sucker. Skin provided with numerous spines placed side by side in alternating rows extending ventrally as far as the posterior border of the testicles, but dorsally not so far; smaller on the cephalic cone than on the body. Pharynx elongate 0.7 mm. long; esophagus 0.4 mm. broad, rarely over 1 to 1.5 times as long as the pharynx, so that the bifurcation of the intestine is immediately anterior of the genital pore; intestinal ceca dendritic, some branches extending into the cephalic cone, and the posterior end of the ceca extending to caudal extremity of worm; lateral branches longer, much more profuse, and more numerous than median branches. Genital pore median, about halfway between the oral sucker and acetabulum. *Male organs:* Cirrus frequently found extruded from pore, and then recurved; cirrus pouch present, containing pars prostatica and vesicula seminalis; testicles profusely branched, situated for the greater part caudad of the transverse vitelloduct. *Female organs:* Vulva at side of cirrus; uterus forms a rosette with numerous coils, and is frequently visible to the naked eye as a dark-brown spot immediately posterior of the ventral acetabulum; ovary branched and anterior of the transverse vitelloduct; vitellaria profusely branched and occupy the entire margin of the body from the acetabulum to the posterior extremity; they lie dorsally as well as ventrally of the intestine, and become broader posteriorly. Excretory system highly developed. *Eggs* (fig. 21) oval, 130 to 145 μ long by 70 to 90 μ broad; miracidium (figs. 22–23) conical, ciliated, with oral papilla, two cup-shaped eye-spots, and rudimentary intestine; metamorphosis (sporocyst, redia, cercaria) takes place in small snails of the genus *Limnæa* (*L. truncatula* and others, figs. 34–38); cercaria (fig. 23) whitish, owing to excessive development of the capsule glands, encysts upon plants.

Fig. 19.—The Common Liver Fluke (*Fasciola hepatica*), natural size. (After Stiles, 1898, p. 29, fig. 2.)

Habitat.—Gall ducts, occasionally lungs, or other portions of the body of cattle (*Bos taurus*), sheep (*Ovis aries*), swine (*Sus scrofa domestica*), and other mammals; rare in man (*Homo sapiens*).

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[a] Vernacular names.—English, *Common Liver Fluke;* German, *Leberegel, Leberwurm, Schafegel;* Dutch, *Botten, Leverworm*; Danish, *Faareflynder;* Swedish, *Levermask;* French, *Douve hepatique, fasciola;* Italian, *biscuola, distoma epatico;* Spanish, *caracolillo.*

Synonyms.—*Fasciola hepatica* Linnæus, 1758; *Planaria latiuscula* Gœze, 1782; *Distoma hepaticum* (Linnæus) Abildgaard (?); *Fasciola humana* Gmelin, 1790; *Distoma* (*Cladocœlium*) *hepaticum* (Linnæus) of Dujardin, 1845; *Fasciolaria hepatica* (Linnæus) Anonymous, 1845; *Distomum hepaticum* (Linnæus) Diesing, 1850; *Distomum* (*Fasciola*) *hepaticum* Linnæus of Leuckart, 1863; *Cladocœlium hepaticum* (Linnæus) Stossich, 1892.

Bibliography.—For bibliography, see Hassall (1894) and Huber (1894). For more technical discussion of this species, see Leuckart (1889, pp. 179–328).

For a summary of the 32 cases thus far reported for man see Blanchard, 1888a, pp. 589–595; Leuckart, 1889, pp. 313–328, or Moniez, 1896, pp. 103–111. For a general discussion of this parasite in English, see Stiles, 1898, pp. 29–48.

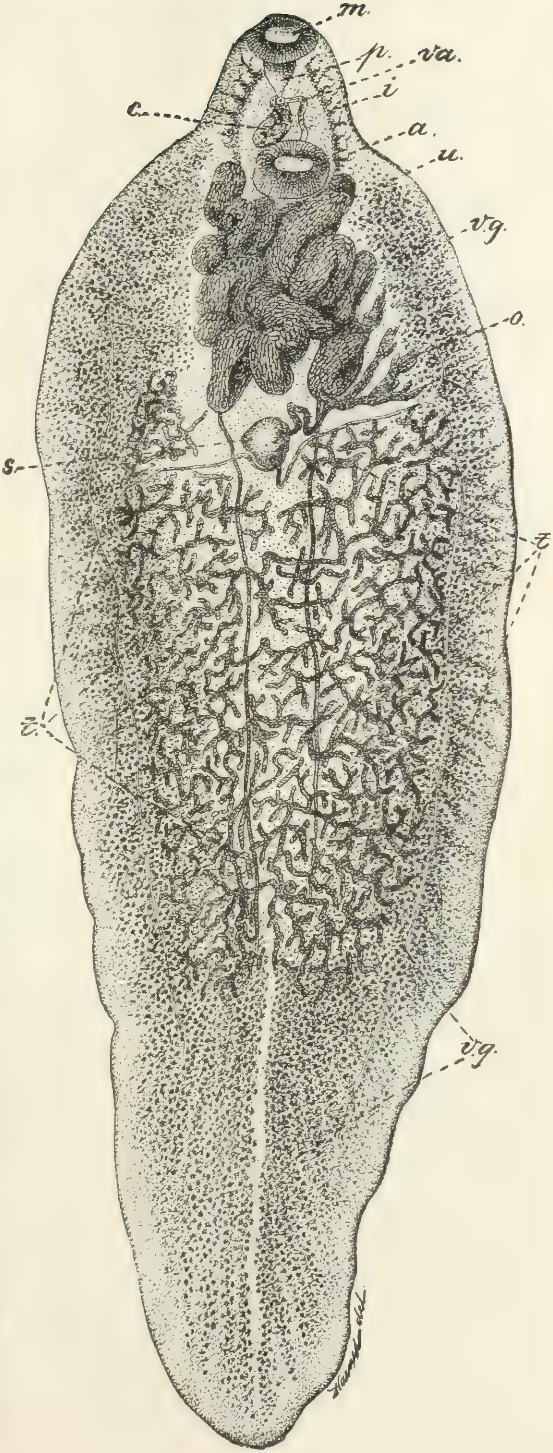

FIG. 20.—The Common Liver Fluke (*Fasciola hepatica*), enlarged to show the anatomic characters: *ac*, acetabulum; *c. p.*, cirrus pouch; *i*, intestinal cecum; *m*, mouth with oral sucker; *ov*, ovary; *p. b.*, pharyngeal bulb; *s. g.*, shell gland; *t*, profusely branched testicles; *ut*, uterus; *va*, vagina; *vg*, profusely branched vitellogene gland. (After Stiles, 1894, p. 300.)

This worm is very common in Europe and not uncommon in the United States. From an agricultural standpoint it is the most important of the flukes, but from a standpoint of human medicine it is much less important than several other forms, notably *Paragonimus*, *Opisthorchis*, and *Schistosoma*.

LIFE HISTORY. As an example of the life history of flukes, we may take that of *Fasciola hepatica*, which may be summarized as follows:

(*a*) The *adult hermaphroditic worm* (figs. 19–20), the characters of which are given on p. 22, fertilizes itself or a cross fertilization of two individuals takes place in the biliary passages of the liver, and produces a large number (estimated at 37,000 to 45,000) of eggs.

(*b*) *Eggs* (figs. 21 and 22).—Each egg is composed of the following parts: (1) A true germ cell, which originates in the ovary and is destined to give rise to the future embryo; (2) a number of vitelline or yolk cells, which are formed in a specialized and independent portion (vitellogene gland) of the female glands; instead of developing into embryos, the yolk cells form a follicle-like covering for the true germ cell and play an important rôle in the nutrition of the latter as it undergoes further development; (3) a shell surrounding the germ cell and the vitelline cells, and provided at one end with a cap or operculum. The eggs escape from the uterus of the adult through the vulva, are carried to the intestine of the host with the bile, then pass through the intestines with the contents of the latter, and are expelled from the host with the fecal matter. Many of them become dried and then undergo no further development, but others are naturally dropped in the water in marshes, or, being dropped on dry ground, they are washed into the water by the rain, or are carried to a more favorable position by the feet of animals pasturing in or passing through the fields. After a longer or shorter period of incubation, which varies with the temperature, a ciliated embryo (miracidium) is developed. At a temperature of 20° to 26° C. the miracidium may be formed in 10 days to 3 weeks; at a temperature of 16° C. the development takes 2 to 3 months; at 38° C. it ceases entirely. Experiments have shown that as long as these eggs remain in the dark the miracidium will not escape from the eggshell; accordingly it will not escape during the night. When exposed to the light, however, or when suddenly brought into contact with cold water, the organism bursts the cap from the eggshell, crawls through the opening and becomes a—

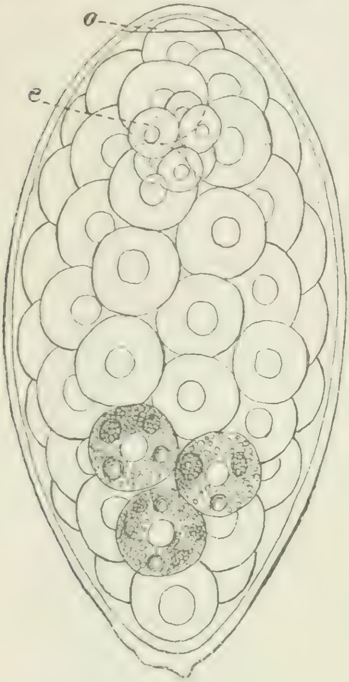

FIG. 21.—Egg of the Common Liver Fluke (*Fasciola hepatica*) examined shortly after it was taken from the liver of a sheep; at one end is seen the lid or operculum, *o*; near it is the segmenting ovum, *e*; the rest of the space is occupied by yolk cells which serve as food; all are granular, but only three are thus drawn. × 680. (After Thomas, 1883, p. 281, fig. 1.)

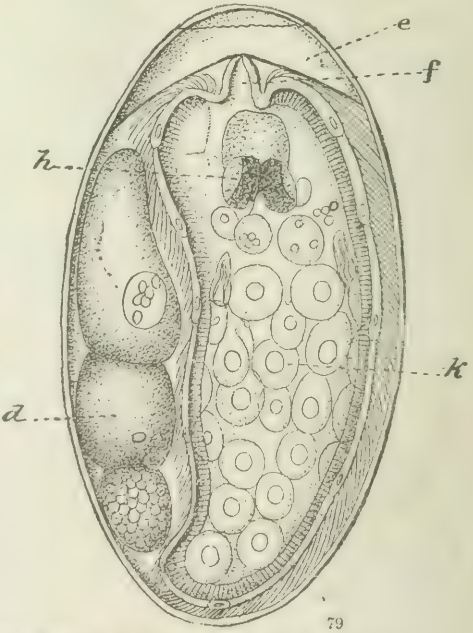

FIG. 22.—Egg of the Common Liver Fluke containing a ciliated embryo (miracidium) ready to hatch out: *d*, remains of food; *e*, cushion of jelly-like substance; *f*, boring papilla; *h*, eye-spots; *k*, germinal cells. × 680. (After Thomas, 1883, p. 283, fig. 2.)

(*c*) *Free-swimming ciliated miracidium* (fig. 23).—As already stated, this organism is entirely different from its mother. It measures about 0.15 mm. long. It is somewhat broader in its anterior portion than in its posterior portion; on its anterior extremity we find a small eminence known as a boring papilla; the exterior surface of the young worm is covered with numerous cilia, which by their motion propel the animal through the water; inside the body we find in the anterior portion a simple vestigial intestine and a double ganglionic mass, provided with a peculiar pigmented double cup-shaped eye-spot; in the posterior portion of the body cavity is found a number of germ cells, which develop into individuals of the next generation.

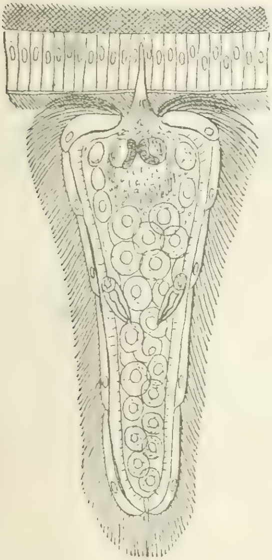
FIG. 23.—Embryo of the Common Liver Fluke (*Fasciola hepatica*) boring into a snail. 370. (After Thomas, 1883, p. 285, fig. 4.)

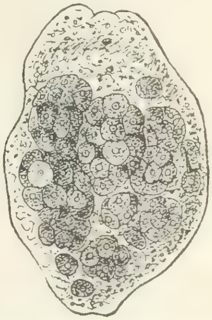
FIG. 24.—Sporocyst of the Common Liver Fluke which has developed from the embryo, and contains germinal cells. × 200. (After Leuckart, 1889, p. 109, fig. 67 *B*.)

Swimming around in the water, the miracidium seeks out certain snails (*Limnæa truncatula*, *L. oahuensis*, *L. rubella*, see p. 38), which it immediately attacks (fig. 23). The miracidium elongates its papilla and fastens itself to the feelers, head, foot, or other exterior soft portions of the body of the snail; some of the parasites enter the pallial (lung) cavity and attach themselves there. After becoming securely fastened to the snail the miracidium discards its ciliated covering and shortens to about half its former length (0.07 mm. to 0.08 mm.). The parasites now bore their way into the body of the snail and come to rest in the liver, or near the roof of the pallial cavity, etc., the movements gradually cease, and we have before us the stage known as the—

(*d*) *Sporocyst* (figs. 24 and 25).—The eye-spots, ganglionic swellings, and vestigial intestine become more and more indistinct and are finally lost. The sporocyst grows slowly at first, then more rapidly, and at the end of 14 days or so measures 0.5 mm. The germ cells mentioned as existing in the posterior portion of the miracidium now develop into individuals of the third generation known as

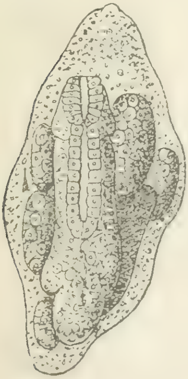
FIG. 25.—Sporocyst of the Common Liver Fluke, somewhat older than that of fig. 24, in which the germinal cells are giving rise to rediæ. × 200. (After Leuckart, 1889, p. 109, fig. 67 *C*.

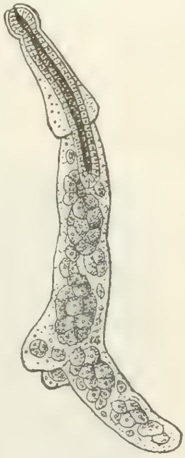
FIG. 26.—Redia of the Common Liver Fluke (*Fasciola hepatica*), containing germinal cells which are developing into cercariæ. 150. (After Leuckart, 1889, p. 269, fig. 129 *A*.)

(*e*) *Rediæ* (figs. 26 and 27).—The rediæ escape from the sporocyst when the latter is from 2 weeks (in summer) to 4 weeks (in late fall) old. Upon leaving the body of the sporocyst they wander to the liver of the snail, where they grow to about 2 mm. long by 0.25 mm. broad. Each redia consists of a cephalic portion, which is extremely motile and which is defined from the rest of the young worm by a ridge; under the latter is situated an opening through which the next generation (cercariæ) escapes. The posterior portion of the worm is provided at about the border of the third and last fourths of the body with two projections. There is a mouth with pharynx situated at the anterior extremity, the pharynx leading into a simple blind intestinal sac. The redia, as well as the sporocyst, may be looked upon as a female organism, and in its body cavity are found a number of germ cells, which develop into individuals of the next generation known as—

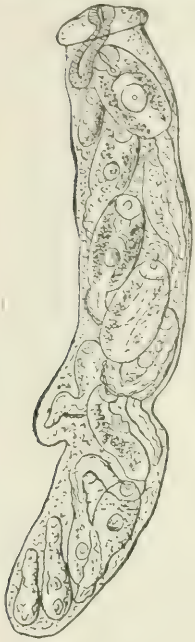

Fig. 27.—Redia of the Common Liver Fluke, with developed cercariæ. × 150. (After Leuckart, 1889, p. 270, fig. 130.)

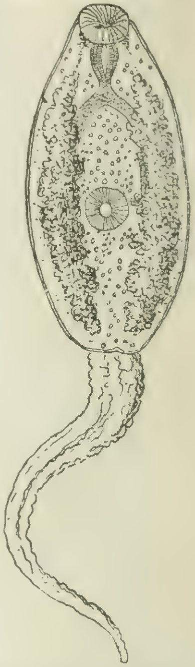

Fig. 28.—Free cercaria of the Common Liver Fluke, showing two suckers, intestine, large glands, and tail. (After Leuckart, 1889, p. 279, fig. 137.)

(*f*) *Cercariæ* (figs. 28–30).—These organisms are quite similar to the adult parasites into which they later develop. The body is flat, more or less oval, and provided with a tail inserted at the posterior extremity. The oral sucker and acetabulum are present as in the adult, but the intestinal tract is very simple; on the sides of the body are seen two large glands, but the complicated genital organs of the adult are not visible. The cercaria leaves the redia through the birth opening, remains in the snail for a longer or shorter time, or passes out of the body of the snail and swims around in the water. After a time it attaches itself to a blade of grass (fig. 29) or some other object, and forms a cyst around itself with material from the large glands, at the same time losing its tail. It now remains quiet until swallowed by some animal. Then upon arriving in the stomach—of a steer, for instance—the cyst is destroyed, and the young parasite wanders through the gall ducts, or, as some believe, through the portal veins to the liver, where it develops into the adult hermaphrodite.

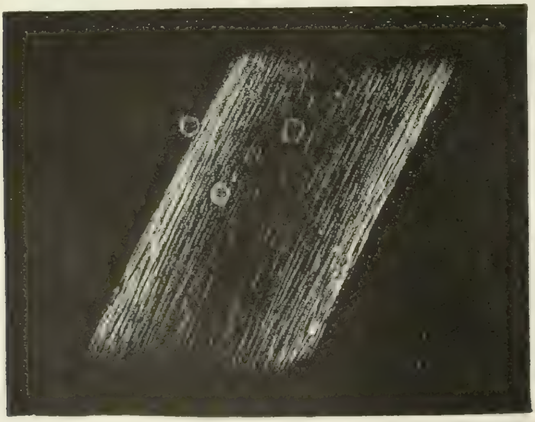

Fig. 29.—Portion of a grass stalk with three encapsuled cercariæ of the Common Liver Fluke (*Fasciola hepatica*). × 10. (After Thomas, 1883, p. 291, fig. 13.)

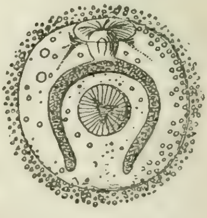

Fig. 30.—Isolated encysted cercaria of the Common Liver Fluke. × 150. (After Leuckart, 1889, p. 286, fig. 142.)

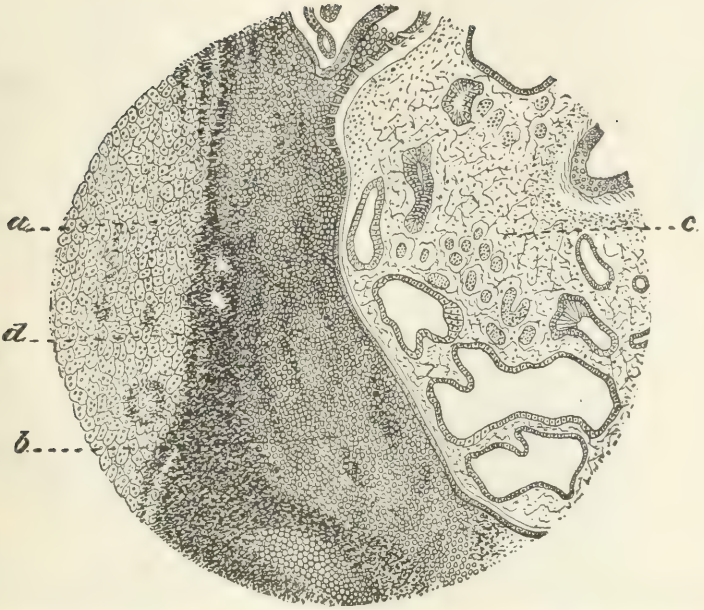

Fig. 31.—Drawing from a microscopic preparation showing a hemorrhage in the parenchyma of the liver caused by the Common Liver Fluke (*Fasciola hepatica*): *a*, atrophic liver tissue; *b*, round cell infiltration; *c*, a portion of the parasite; *d*, hemorrhage. (After Schaper, 1890, Pl. 1, fig. 1.)

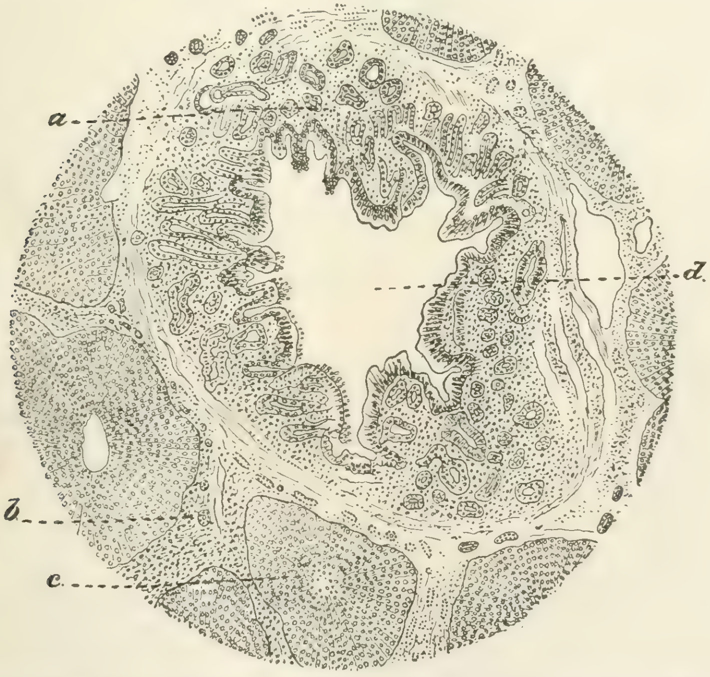

Fig. 32.—Drawing from a microscopic preparation showing the glandular hyperplasia of the mucosa of a gall duct caused by the Common Liver Fluke (*Fasciola hepatica*): *a*, hypertrophied submucosa; *b*, interstitial connective tissue; *c*, compressed lobule; *d*, lumen of the gall duct; thickened fibrous wall of the gall duct. (After Schaper, 1890, Pl. 1, fig. 2.)

Genus DICROCŒLIUM[a] Dujardin, 1845.

GENERIC DIAGNOSIS.—Fasciolidæ: Body of rather slender build, elongate, and flat; anterior and posterior ends more or less pointed. Suckers rather approached to each other; ventral acetabulum usually more highly developed than the oral sucker. Skin smooth. Intestine with pharynx, moderately long esophagus, and long simple ceca.

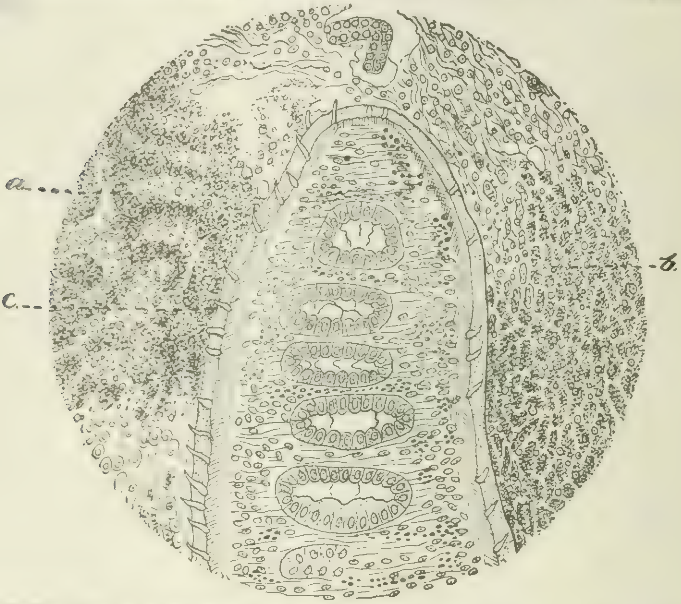

FIG. 33.—Drawing from a microscopic preparation showing a fluke in the tissue of the liver: *a*, necrotic liver tissue; *b*, atrophic liver cells; *c*, spines on the fluke, showing the outline of the body. (After Schaper, 1890, Pl. 3, fig. 5.)

Excretory system simple, tubular. *Genital pore* median, between the suckers. Copulatory organs present, but not highly developed. *Male organs:* Cirrus pouch lies almost entirely anterior of ventral acetabulum; in its posterior end is a more or less coiled vesicula seminalis, anterior of this the moderately developed pars prostatica, and a comparatively long, thin cirrus (including ductus ejaculatorius); testicles compact, one quite straight behind the other, directly posterior of the ventral sucker. *Female organs:* Ovary about median, smaller than the testicles, and immediately

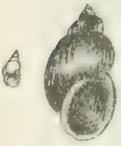

FIG. 34.—*Limnæa truncatula*, natural size and enlarged. (After Leuckart.)

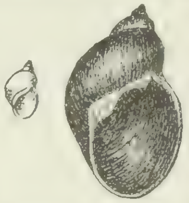

FIG. 35.—*Limnæa pere gra*, natural size and enlarged. (After Leuckart.)

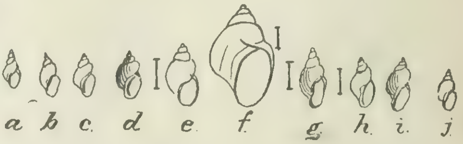

FIG. 36.—*Limnæa humilis*, natural size and enlarged. (After Binney.)

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[a] SYNONYMS.—*Distoma (Dicrocœlium)* Dujardin, 1845; *Dicrocœlium* Dujardin of E. Blanchard, 1847a; *Dicrocælium* (misprint) of several authors.

posterior of them, receptaculum seminis and Laurer's canal present; vitellaria moderately developed, lateral of the intestinal ceca; uterine coils numerous, distinctly transverse, confined to space posterior of genital glands. *Eggs* quite numerous; when ripe of a more or less deep brown color, and varying in size from 36 to 47 μ by 21 to 31 μ.

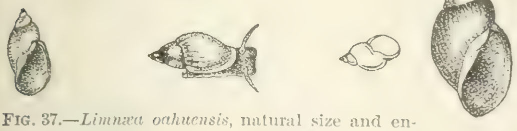
FIG. 37.—*Limnæa oahuensis*, natural size and enlarged. (After Souleyet.

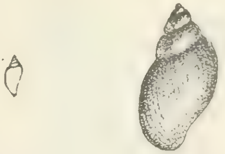
FIG. 38.—*Limnæa viator*, natural size and enlarged. After d'Orbigny.)

HABITAT.—With one exception, parasitic in liver and gall bladder of warm-blooded animals (mammals and birds).

TYPE-SPECIES.—*Dicrocœlium lanceatum* Stiles & Hassall, 1896.

The Lancet Fluke –DICROCŒLIUM LANCEATUM[a] Stiles & Hassall, 1896—of Ruminants, Man, etc.

[Figs. 39 to 41.]

SPECIFIC DIAGNOSIS.—*Dicrocœlium:* 4 to 9 mm. long, 2 to 2.4 mm. broad; thin, lanceolate, more pointed anteriorally than posteriorly. Acetabulum slightly larger than oral sucker, the latter slightly subterminal; distance between the two, about one-fifth the length of the body. Skin without spines. Pharynx small (0.25 mm.), globular; esophagus about 2.5 to 3 times as long as the pharynx, so that the bifurcation of the intestine is immediately anterior of the genital pore; intestinal ceca extend to posterior quarter of body. Genital pore about halfway between suckers, immediately posterior of bifurcation of intestine. *Male organs:* Cirrus pouch extends from genital pore to ventral acetabulum and contains the pars prostatica and vesicula seminalis; testicles irregularly lobate, one caudad of the other, directly caudad of ventral acetabulum. *Female organs:* Ovary small, directly caudad of posterior testicle, but anterior of transverse vitelloducts; uterus confined between the intestinal ceca, but in posterior fourth of body there is a tendency for the coils to extend nearer the lateral margins; vitellaria only moderately developed, marginal, in equatorial third of body. *Eggs* 38 to 45 μ long by 22 to 30 μ broad, contain embryos when oviposited. Sporocyst, redia, cercaria, and intermediate host undetermined.

HABITAT.—Gall ducts of cattle (*Bos taurus*), sheep (*Ovis aries*), ass (*Equus asinus*), man (*Homo sapiens*), etc.

GEOGRAPHIC DISTRIBUTION.—Very extended, especially in Europe, but apparently not in England or North America.

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[a] VERNACULAR NAMES.—English, *Lancet fluke;* German, *der lanzettförmige Leberegel, das lanzettförmige Doppelloch;* French, *distome lancéolé;* Italian, *distoma lanceolato.*

SYNONYMS.—*Fasciola lanceolata* Rudolphi, 1803 (not Schrank, 1790); *Distoma lanceolatum* (Rudolphi) Mehlis, 1825; "*Distoma* (*Dicrocœlium*) *lanceolatum* Mehlis" of Dujardin, 1845; "*Distomum lanceolatum* Mehlis" of Diesing, 1850; "*Dicrocœlium lanceolatum* Dujardin" of Weinland, 1858; "*Fasciola Buchholzii* Jördens, 1801," misprint of Braun, 1889; *Dicrocœlium lanceatum* Stiles & Hassall, 1896.

BIBLIOGRAPHY.—No extensive bibliography as yet published. For detailed technical discussion see Leuckart (1889, pp. 359–399). For a review of seven cases of infection compiled for man consult Blanchard, 1888a, pp. 611–612. Leuckart, 1899, pp. 391–399, or Moniez, 1896, pp. 120–122.

Genus OPISTHORCHIS Blanchard,[a] 1895.

GENERIC DIAGNOSIS.—Fasciolidæ: Body distinctly, often very greatly, elongated; anterior end attenuated, posterior end broader. Skin smooth, often without spines. Suckers not far separated, and usually not especially large. Intestine with pharynx, short slender esophagus, and long simple ceca. Excretory system with long sigmoid stem usually winding between the testicles, and with short branches. *Genital pore* median, immediately in front of acetabulum. Copulatory organs absent. *Male organs:* Testicles in posterior portion of body, one posterior of the other, more or less distinctly lobate, or even branched. *Female organs:* Ovary simple or lobate, anterior of testicles; Laurer's canal present; receptaculum seminis very greatly developed; uterine coils anterior of testicles and ovary, but not extending materially over the intestinal ceca; vitellaria moderately developed, lateral of intestinal ceca, not extending anteriorly beyond the ventral acetabulum.

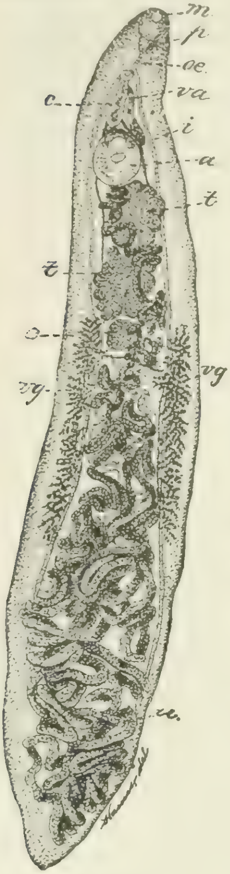

FIG. 39.—Lancet Fluke, enlarged to show the anatomic characters: *a.*, acetabulum; *c. p.*, cirrus pouch; *i*, intestinal ceca; *m*, mouth with oral sucker; *o.*, ovary; *œ*, esophagus; *p. b.*, pharyngeal bulb; *t*, lobate testicles; *ut.*, uterus; *va*, vagina; *vg*, vitellogene glands. (After Stiles & Hassall, 1894, Pl. 4, fig. 19.)

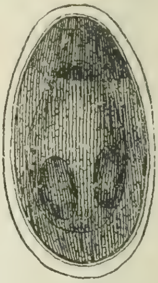

FIG. 40.—Egg of Lancet Fluke (*Dicrocœlium lanceatum*), with contained embryo. × 700. (After Leuckart, 1889, p. 379, fig. 171.)

HABITAT.—Parasitic in the gall-ducts of warm-blooded animals (mammals and birds).

TYPE SPECIES.—*Opisthorchis felineus* (Rivolta, 1884).

KEY TO SPECIES OF OPISTHORCHIS REPORTED FOR MAN.

(For species thus far found in the United States, follow Roman type.)

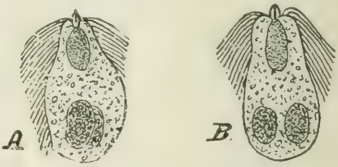

FIG. 41.—Free embryo (miracidium) of the Lancet Fluke; *A*, lateral view; *B*, dorsal view. (After Leuckart, 1889, p. 385, fig. 175 *A*, *B*.)

1. Testicles branched, and frequently extending beyond the intestinal ceca into the lateral fields; excretory system runs dorsally of testicles; Asia, but imported cases elsewhere............. *O. sinensis* (p. 35)

Testicles may be lobate, but not branched, and are confined to median field between the intestinal ceca; excretory system sigmoid extending between the testicles.. 2

2. *Spines present on skin; vitellaria extend caudally of first testicle to about the anterior border of posterior testicle; worm not over 12 mm. long; ventral acetabulum close to bifurcation of intestine; India*.............................. *O. noverca* (p. 33)

Spines absent; vitellaria not reaching or barely reaching the first testicle; worm 10 to 18 mm. long; ventral acetabulum some distance from bifurcation of intestine; Europe.................................... *O. felineus* (p. 31)

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[a] SYNONYMS.—*Opisthorchis* Blanchard, 1895; *Opistorchis* Railliet, 1896 (misprint); "*Campula* Cobbold," of Stiles & Hassall, 1898 (in part); *Opisthorchic* Stiles, 1901 (misprint).

The European Cat Fluke—OPISTHORCHIS FELINEUS[a] (Rivolta, 1884) Blanchard 1895—of Cats, Dogs, Man, etc.

[Figs. 42 to 44.]

Specific diagnosis.—*Opisthorchis*: 8 to 13 mm., seldom 18 mm. long, 1.25 to 2.5 mm. broad; flat, lanceolate, anterior end conical, posterior end rounded; the anterior fifth of the body more or less constricted from the posterior four-fifths; reddish, transparent. Oral sucker and ventral acetabulum of same size, 0.28 mm. in diameter; oral sucker terminal to subterminal; ventral sucker at plane of constriction between anterior fifth and posterior four-fifths of body. Skin without spines. Pharynx small, 0.204 mm. long, 0.161 mm. broad, follows the oral sucker; esophagus 0.2 mm. long; intestinal ceca extend to posterior end of body. *Male organs:* Testicles lobate. *Female organs:* Uterus moderately well developed; ovary slightly lobate; shell gland diffuse, composed of unicellular glands; receptaculum seminis postero-lateral of ovary; vitellaria lateral in equatorial third of body, and composed of seven to nine groups of acini on each side; transverse vitelloduct runs postero-median. *Eggs* oval, 26 to 30 μ by 11 to 15 μ, with sharply defined operculum on the more acute pole; contain ciliated embryo at oviposition. Sporocyst, redia, cercaria, and intermediate host undetermined.

Habitat.—Gall ducts of the domesticated cat (*Felis catus domestica*), domesticated dog (*Canis familiaris*), glutton (*Gulo borealis*), and man (*Homo sapiens*).

Geographic distribution.—Europe (Germany, Holland, Italy, France, and Russia).

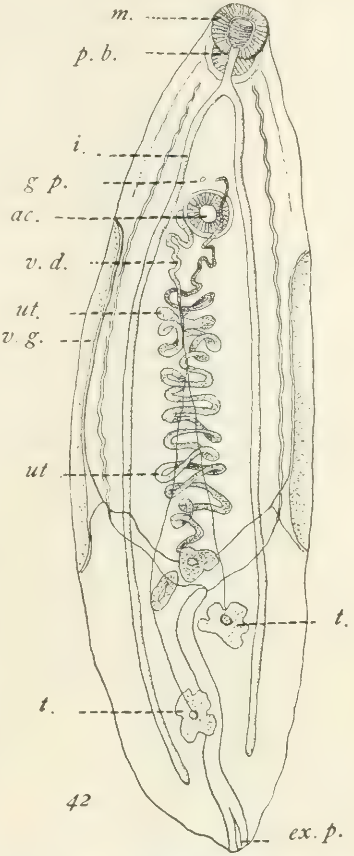

Fig. 42.—Rivolta's (1884) original figure of *Opisthorchis felineus*: *ac.*, acetabulum; *ex. p.*, excretory pore; *g. p.*, genital pore; *i.*, intestinal ceca; *m.*, mouth; *p. b.*, pharyngeal bulb; *t.*, testicles; *ut.*, uterus; *v. d.*, vas deferens; *v. g.*, vitellogene gland.

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[a] Synonyms.—*Distoma conus* Gurlt, 1831 (not Creplin, 1825); "*Distoma lanceolatum*" of von Siebold, 1836 (not *Fasciola lanceolata* Schrank, 1790); "*Distomum lanceolatum* Mehlis" of Diesing, 1850 (sub *D. truncatum*); *Distomum felineum* Rivolta, 1884; "*Distomum conus*" of Sonsino, 1889 (sub *D. truncatum*); *Distomum sibiricum* Winogradoff, 1902; *Distomum* (*Dicrocœlium*) *felineum* Rivolta of Braun, 1893; *Distoma* (*Dicrocœlium*) *felineum* Rivolta of Stiles, 1894 (sub *D. truncatum*); *Opisthorchis felineus* (Rivolta, 1894) R. Blanchard, 1895; *Opisthorchic felineus* (Rivolta) Stiles, 1901 (misprint).

Bibliography.—Stiles & Hassall, 1894, pp. 426–427.

This parasite has been reported for man in Prussia, and Winogradoff found it in Siberia in 8 (or 9) out of 124 post-mortem examinations of human cadavers. It is essentially an Old World species, but it may be found at any time in Europeans who have immigrated to the United States, and the possibility is by no means excluded that it may be found in American troops who have served in China or the Philippines.

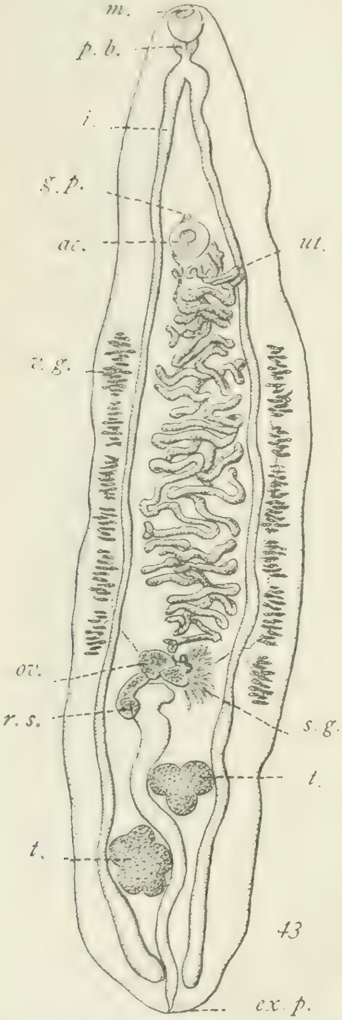

Fig. 43.—*Opisthorchis felineus* from a cat, collected in Prussia by Max Braun. Greatly enlarged to show the anatomy: ov., ovary; r. s., receptaculum seminis; s. g., shell gland; other letters same as fig. 42. (After Stiles & Hassall, 1894, fig. 6.)

Ward (1895) has recorded this species for cats in Nebraska, but a comparison of his specimens with authentic material of *O. felineus* from Europe has convinced both him and me that the Nebraskan parasite represents a distinct form. Since it is so closely allied to *O. felineus*, further since both species occur in cats and the European form occurs in man also, it need occasion no surprise if Ward's parasite is found sooner or later in man. Its characters may be seen from the following diagnosis:

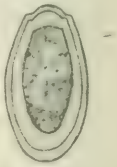

Fig. 44.—Egg of *Opisthorchis felineus*. × 830. (After Braun, 1903, p. 185, fig. 105.

Opisthorchis pseudofelineus[a] Ward, 1901 (fig. 45); *Opisthorchis:* 12 to 20 mm. long, 1 to 2.5 mm. broad; form somewhat similar to that of *O. felineus*, but more elongate. Oral sucker 0.355 mm. by 0.414 mm., terminal to subterminal; ventral acetabulum somewhat smaller, 0.247 mm. by 0.240 mm., situated slightly anterior of border between first and second anterior fourths of body. Skin provided with minute scale-like spines which are lacking, however, on posterior portion of body. Pharynx 0.212 mm. by 0.219 mm.; esophagus 0.175 mm. long; intestinal ceca extend to posterior extremity. *Male organs:* Testicles round or lobate. *Female organs:* Uterus well developed, the coils often being quite crowded; ovary globular; receptaculum seminis large, postero-lateral of ovary; vitellaria divided each side into an antovarial portion with about five acini and a postovarial portion with two or three acini, each portion provided with its own vitelloduct; the antovarial portion extends from the ovary cephalad to about the boundary between the anterior and equatorial thirds of the body; the postovarial portion extends caudad from the ovary to about the anterior plane of the posterior testicle; Laurer's canal prominent. *Eggs* 25 to 35 μ by 12 to 15 μ. Sporocyst, redia, cercaria, and intermediate host undetermined.

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[a] Synonyms.—"*Distoma felineum*" of Ward, 1895; *Opisthorchis pseudofelineus* Ward, 1901.

Bibliography.—For more detailed description see Ward, 1895, pp. 152–158.

HABITAT.—Gall ducts of the domesticated cat (*Felis catus domestica*) and coyote (*Canis latrans* Say).

GEOGRAPHIC DISTRIBUTION.—United States (Nebraska and Iowa).

Winogradoff reports that in one of his nine cases of *Opisthorchis felineus* in man, he found a small spinose distome, and as *O. felineus* is not spinose, Braun (1896) suggests that the parasite might have been *Metorchis albidus* or *M. truncatus*, species found in cats in Europe.

The Indian Liver-Fluke — OPISTHORCHIS NOVERCA[a] **Braun, 1903—of Man.**

[Figs. 46 to 48.]

SPECIFIC DIAGNOSIS. — *Opisthorchis:* 9 to 12.5 mm. long, 2.5 mm. broad; lanceolate more attenuate anteriorly than posteriorly. Oral sucker terminal. Ventral acetabulum much smaller than oral sucker; distance between the two equal to about one-eighth the length of the body, the acetabulum being rather near the bifurcation of the intestine. Skin thickly beset with spines. Pharynx large; esophagus appar-

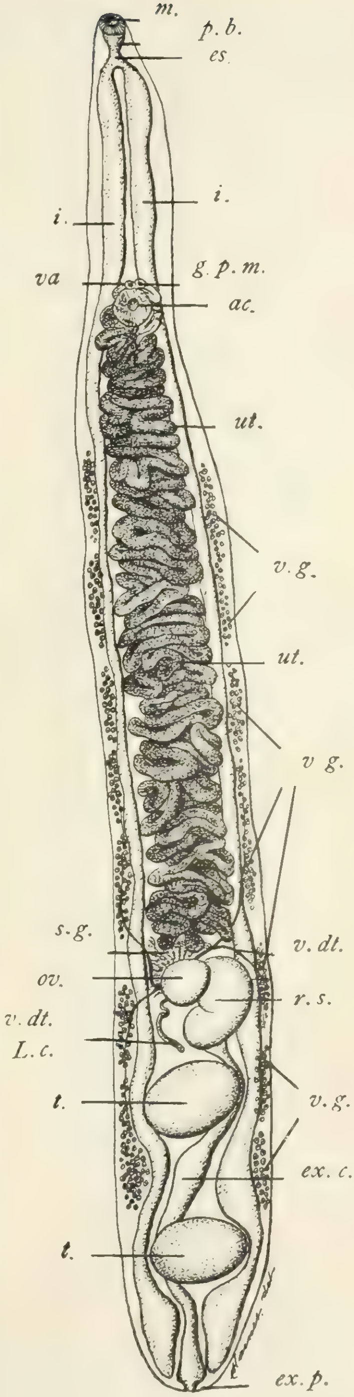

FIG. 45.—*Opisthorchis pseudofelineus* from a specimen (U.S.N.M., No. 1447) collected in Iowa from the gall ducts of the cat, greatly enlarged to show the anatomy: *ac.*, acetabulum, *es.*, esophagus; *ex. c.*, excretory canal; *ex. p.*, excretory pore; *g. p. m.*, male genital pore; *i.*, intestinal ceca; *L. c.*, Laurer's canal; *m.*, mouth with oral sucker; *ov.*, ovary; *p. b.*, pharyngeal bulb; *r. s.*, receptaculum seminis; *s. g.*, shell gland; *t.*, testicles; *ut.*, uterus; *va.*, vagina (metraterm); *v. g.*, vitellogene glands; *v. dt.*, vitelloduct. Original.

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[a] SYNONYMS.—"*Distoma conjunctum* Cobbold" of Lewis & Cunningham 1872.

ently absent: intestinal ceca extend to about the border of posterior eighth of body. *Male organs:* Testicles apparently round to lobate, situated in posterior third of body. *Female organs:* Uterus apparently poorly developed; ovary?; receptaculum seminis?; Laurer's canal?; vitellaria apparently extend from ventral acetabulum to posterior testicle. *Eggs* oval, 34 *µ* by 19 to 21 *µ*. Sporocyst, redia, cercaria, and intermediate host undetermined.

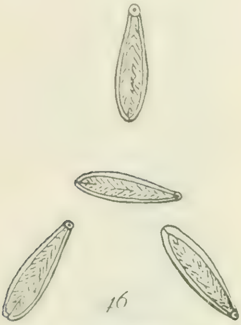

Fig. 46.—*Opisthorchis noverca.* Natural size. (After McConnell, 1876, fig. 2.

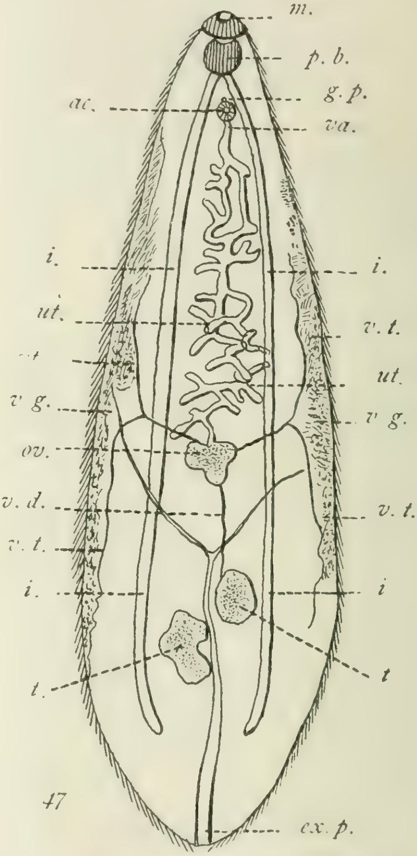

Fig. 47.—Ventral view of *Opisthorchis noverca*, greatly enlarged to show the anatomy: *ac.*, acetabulum; *ex. p.*, excretory pore; *g. p.*, genital pore; *i.*, intestinal ceca; *m.*, mouth with oral sucker; *ov.*, ovary and other adjacent organs; *p. b.*, pharyngeal bulb; *s. g.*, shell gland; *t.*, testicles; *ut.*, uterus; *va.*, vagina; *v. d.*, vas deferens; *v. g.*, vitellaria; *v. t.*, vitelloduct. (After McConnell, 1876, fig. 1.)

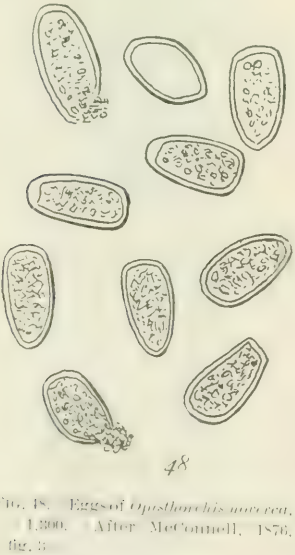

Fig. 48.—Eggs of *Opisthorchis noverca.* ×300. (After McConnell, 1876, fig. 3.)

Habitat.—Gall ducts of man (*Homo sapiens*) and pariah dogs (*Canis familiaris*).

Geographic distribution.—India.

This parasite has been confused with *Metorchis conjunctus* (Cobbold, 1862) of the American Red fox (*Canis fulvus*), but the two worms are evidently distinct. The above diagnosis is based chiefly upon McConnell's figures. The species needs a careful restudy.

For the two cases reported in man, see McConnell, 1876 and 1878.

The Asiatic Liver Fluke—OPISTHORCHIS SINENSIS[a] (Cobbold, 1875) Blanchard, 1895—of Man.

[Figs. 49 to 62.]

FIG. 49.—The Asiatic liver fluke (*Opisthorchis sinensis*). Natural size, from specimen (U.S.P.H. & M.H.S. No. 9410) collected in San Francisco by Asst. Surg. M. J. White. Original.

SPECIFIC DIAGNOSIS.—*Opisthorchis:* 10 to 20 mm. long, 2 to 5 mm. broad; flat, lanceolate to oblong oval, attenuate anteriorly, rounded posteriorly; reddish, nearly transparent during life. Oral sucker larger than ventral acetabulum, which is about on border between first and second fourths of body. Skin without spines. Pharynx globular, about 0.22 mm. in diameter; esophagus 0.17 mm. long, not longer than pharynx; bifurcation of intestine nearer to oral sucker than to acetabulum; intestinal ceca slender, extending to posterior end of body. *Male organs:* Testicles in posterior third of body, branched, usually extending beyond intestinal ceca into the lateral fields and situated ventrally of the sigmoid excretory canal. *Female organs:* Uterus moderately developed; ovary trilobate; immediately anterior of the large elongate vesicula seminalis;

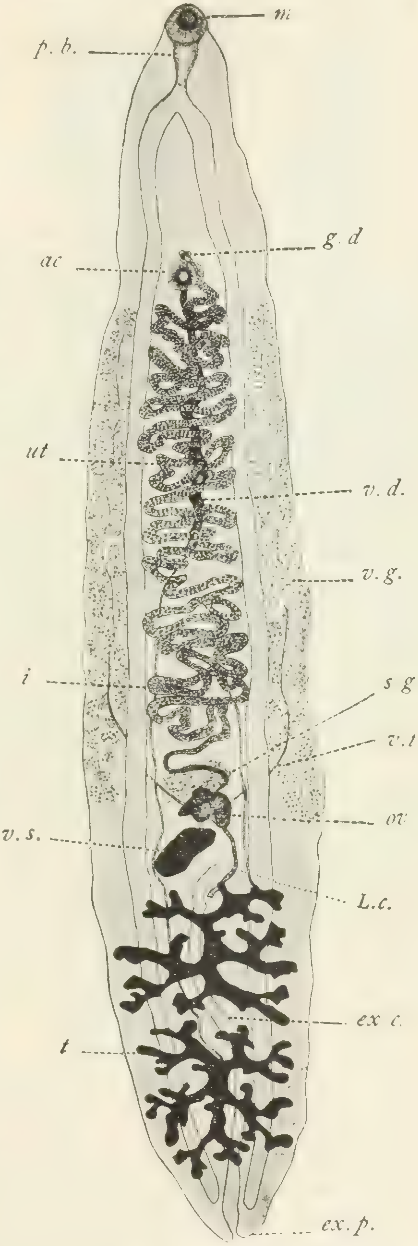

FIG. 50.—The same, ventral view, greatly enlarged to show the anatomy: *ac.*, acetabulum; *ex. c.*, excretory canal; *ex. p.*, excretory pore; *g. p.*, genital pore; *i.*, intestinal ceca; *L. c.*, Laurer's canal; *m.*, mouth, with oral sucker; *ov.*, ovary; *p.b.*, pharyngeal bulb; *s. g.*, shell gland; *t.*, testicles; *ut.*, uterus; *v. d.*, vas deferens; *v. g.*, vitellogene glands; *v. s.*, vesicula seminalis; *v. t.*, vitelloduct. Original.

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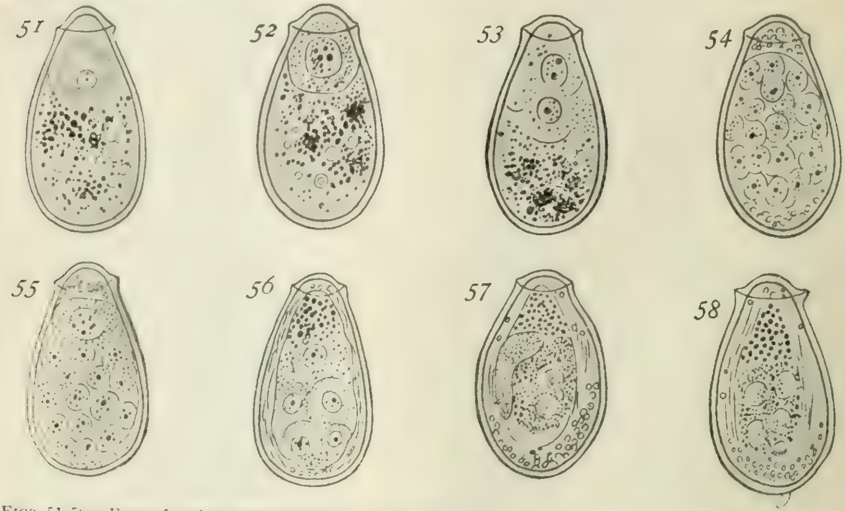
[a] SYNONYMS.—*Distoma sinense* Cobbold, 1875; *Distoma sineuse* of McConnell, 1876 (misprint); *Distomum spathulatum* Leuckart, 1876 (not Creplin, 1849; for *spatulatum* Rudolphi, 1819); *Distomum spatulatum* Cobbold, 1879 (not Rudolphi, 1819); *Distoma hepatis endemicum* Baelz, 1883; *Distoma hepatis innocuum* Baelz, 1883; *Distoma hepatis perniciosum* Baelz, 1883; *Distoma spatulatum* (Cobbold, 1879) Blanchard, 1888; *Distoma japonicum* R. Blanchard, 1886 or 1888; *Distomum sinense* (Cobbold) Leuckart, 1889; *Opisthorchis sinensis* (Cobbold, 1875) R. Blanchard, 1895; *Dicrocœlium sinense* (Cobbold) Moniez, 1896.

BIBLIOGRAPHY.—For technical zoological discussion, see Leuckart (1889, pp. 336 to 355, figs. 154 to 161); for medical discussion, with record of 76 autopsies, see Katsurada (1900, pp. 479–504). White (1902, p. 523) has found 18 cases in San Francisco.

vitellaria moderately developed, occupying about the equatorial third of the body. *Eggs* oval, 27 to 30 μ by 15 to 17 μ; dark brown, with sharply defined operculum; contain ciliated embryo at oviposition. Sporocyst, redia, circaria, and intermediate host undetermined.

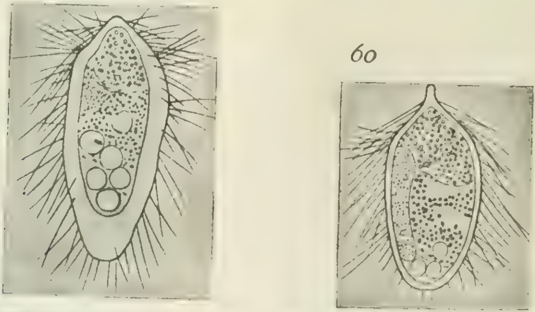


Figs. 51–58.—Eggs of *Opisthorchis sinensis* in different stages of development, as found in the uterus. Note the operculum at one end. Greatly enlarged. (After Katsurada, 1900, pl. 13, figs. 2–9.)

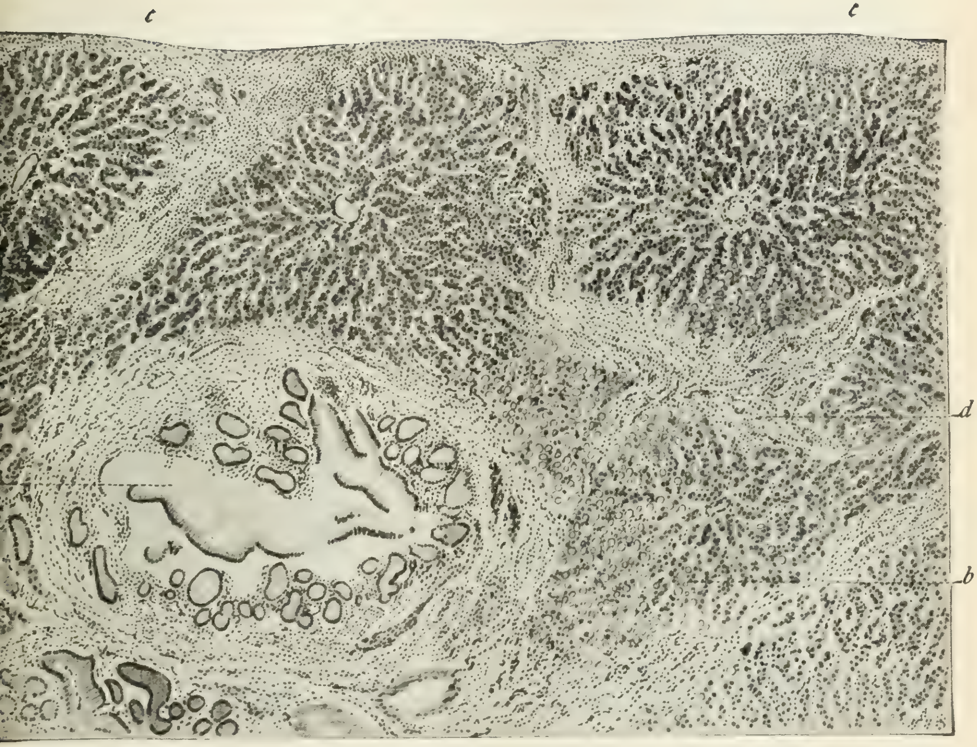
Habitat.—Gall ducts, pancreatic ducts, duodenum, and stomach of man (*Homo sapiens*) and cats (*Felis catus domestica*).

Geographic distribution.—Asia; sporadic imported cases elsewhere.

Several imported cases of this parasite have been found in the United States and Canada. In some of the Japanese cases that have been recorded several thousand parasites have been present, and while the hepatic ducts are more frequently affected, some cases are recorded of the presence of this fluke in the pancreatic ducts, in the duodenum, and in the stomach. See p. 8.



Figs. 59–60.—Free embryos (miracidia) of same. Greatly enlarged. (After Katsurada, 1900, pl. 13, figs. 10–11.)



G. 61.—Section through the left lobe of the liver, showing lesions caused by *Opisthorchis sinensis: a.*, thickened gall duct; *b.*, hyperplastic connective tissue; *c.*, thickened capsule; *d.*, fatty or more or less atrophied liver tissue. × 40. (After Katsurada, 1900, pl. 13, fig. 12.)

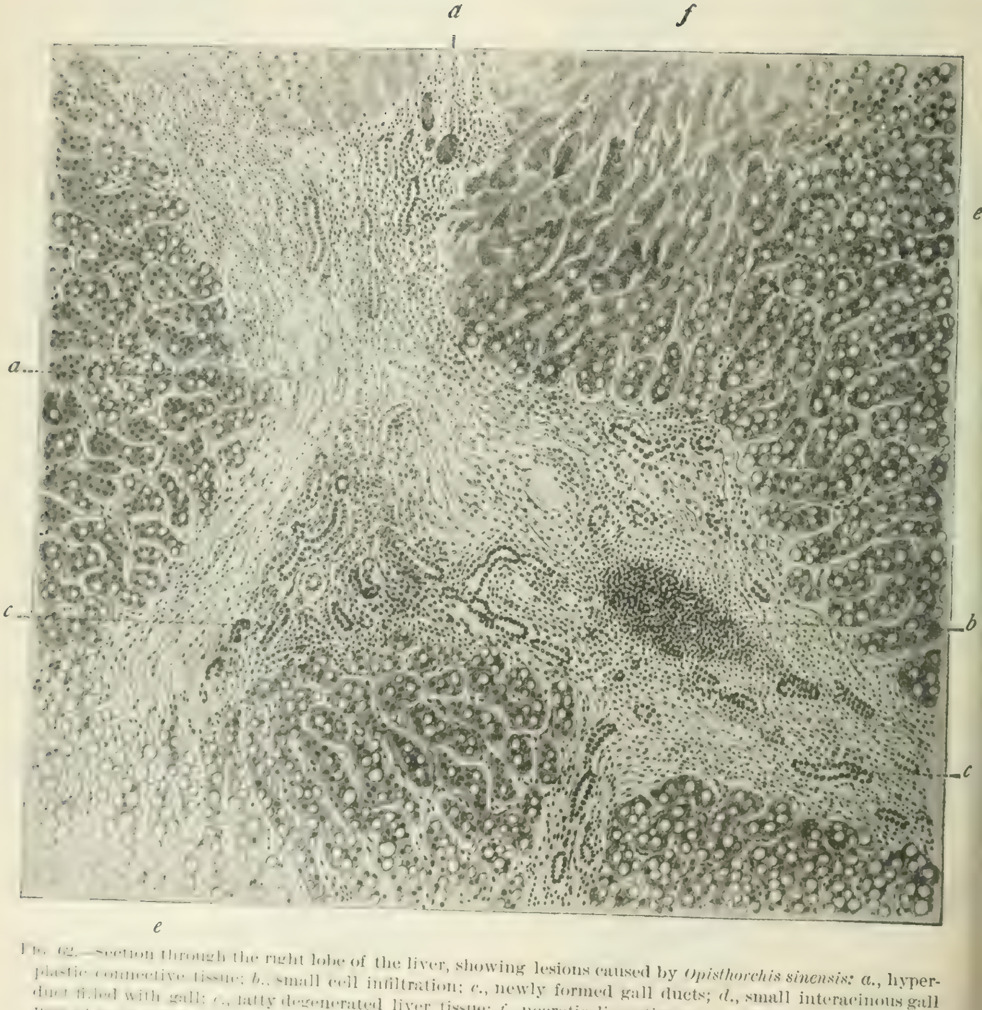


Fig. 62.—Section through the right lobe of the liver, showing lesions caused by *Opisthorchis sinensis:* *a.*, hyperplastic connective tissue; *b.*, small cell infiltration; *c.*, newly formed gall ducts; *d.*, small interacinous gall duct filled with gall; *e.*, fatty degenerated liver tissue; *f.*, necrotic liver tissue. × 40. (After Katsurada, 1900, pl. 13, fig. 13.)

INTESTINAL DISTOMATOSIS.

The exact extent to which distomes in the intestine incommode a patient is not yet determined. It seems rather doubtful whether *Heterophyes* is of much appreciable medical importance, although a heavy infection should not be ignored. *Fasciolopsis*, being much larger, is probably of more importance. Cobbold, for instance, records it for two cases where there were signs of intestinal irritation, such as repeated attacks of diarrhea. The medical importance of *Gastrodiscus* is yet to be established.

In general, it may be said that the importance of intestinal as well as other flukes is a relative question. A few parasites may do little harm, still they actually must do some injury, even if it amounts to simply taking food which should go to the host; an increased infection increases the amount of damage.

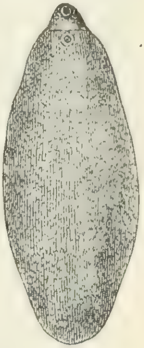


FIG. 63.—*Fasciolopsis buskii.* Natural size. (After Leuckart, 1863, p. 586, fig. 196.)

CLINICAL DIAGNOSIS.—Microscopic examination of fresh stools for eggs; examine also the sputum and the urine in order to eliminate the lung infection with *Paragonimus* and the blood infection with *Schistosoma.*

SYMPTOMS.—Still to be further determined; probably general symptoms of intestinal irritation. Indigestion, nausea, headache, diarrhea, and bloody stools have been observed.

TREATMENT.—Favorable results have been obtained by Dobson with thymol. Aloes, followed by castor oil, also aloes and asafetida, followed by scammony, have failed (Cobbold's cases). As the parasites are plathelminthes, I would suggest the use of same anthelmintics adopted for tapeworms.

Family FASCIOLIDÆ.

Genus FASCIOLOPSIS Looss,[a] 1899.

GENERIC DIAGNOSIS.—Fasciolidæ: Body rather large, flat, about one-third as broad as long, lanceolate to tongue-shaped. Cephalic cone wanting. Skin without spines. Ventral acetabulum larger than oral sucker and nearer anterior end. Intestine with short prepharynx, strong globular pharynx, and exceedingly short esophagus; intes-

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[a] SYNONYMS.—*Fasciolopsis* Looss, 1899; *Fasciolopis* Odhner, 1902 (misprint).

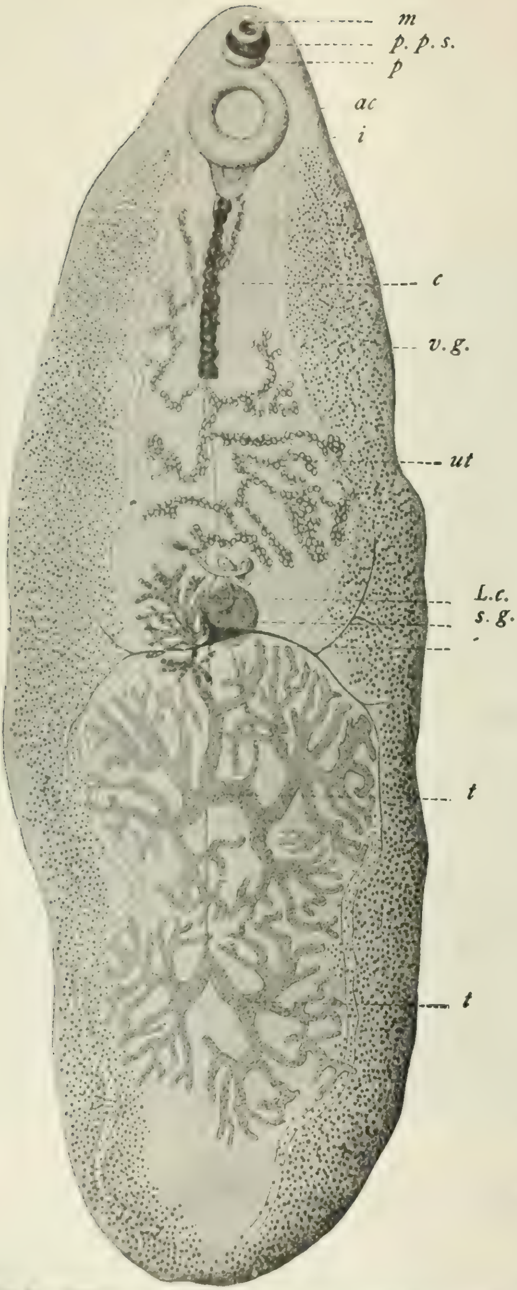

Fig. 61.—Ventral view of *Fasciolopsis buskii*, enlarged to show the anatomy: *ac.*, acetabulum; *c.*, cirrus; *L. c.*, Laurer's canal; *m.*, mouth with oral sucker; *ov.*, ovary; *p.*, pharynx; *p. p. s.*, prepharyngeal sphincter; *s. g.*, shell gland, *t.*, testicles; *ut.*, uterus; *v. g.*, vitellogene glands. × 6. (After Odhner, 1902, fig. 1.)

tinal ceca branch immediately anterior of ventral acetabulum, are narrow and long, extending along inner margin of vitellaria to the posterior end of the body, and are not provided with secondary branches. Excretory system similar to that of *Fasciola*. *Genital pores* empty into genital sinus which is situated in the ventro-median line immediately anterior of acetabulum. Copulatory organs present, the cirrus pouch being a long, straight, median tube extending caudad to a point about half way between ventral acetabulum and shell-gland. *Male organs:* Testicles in the posterior half of median field, side by side, or one posterior of the other, both branched dicotomously. *Female organs:* Ovary moderately developed, branched, located at equator, right of median line; receptaculum seminis absent; Laurer's canal present; vitellaria well developed, with very small acini, and extend from plane of ventral acetabulum to caudal pole of body, where the acini from the two sides may meet in the median line; transverse section of body shows acini to be superficial both dorsally and ventrally; transverse vitello-ducts meet in median line of equator to form the vitelline reservoir; shell-gland compact, well developed, globular; uterus extends from equator forward, with lateral coils, and leads to the well-developed metraterm at caudal border of acetabulum. *Eggs* rather numerous, similar in form to those of *Fasciola*.

Habitat.—Intestine of mammals.

Type species.—*Fasciolopsis buskii* (Lankester, 1857).

Busk's Intestinal Fluke—FASCIOLOPSIS BUSKII[a] (Lankester, 1857) Stiles, 1901—of Man.

[Figs. 63 to 66.]

Specific diagnosis.—*Fasciolopsis:* 24 to 37 mm. (75 mm. after Busk) long, 5.5 to 12 or 14 mm. broad, 1.5 to 2 mm. thick; maximal breadth in equatorial portion;

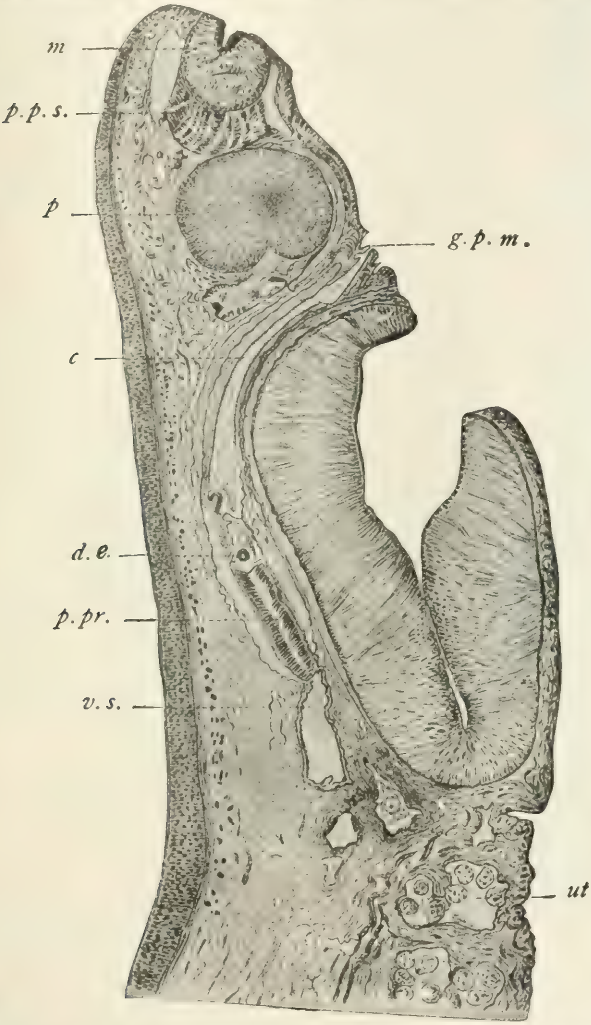

Fig. 65.—Sagittal section of cephalic end of *Fasciolopsis buskii*, slightly to the right of the median line: *d. e.*, ductus ejaculatorius; *g. p. m.*, male genital pore; *p. pr.*, pars prostatica; *v. s.*, vesicula seminalis; other letters same as in fig. 64. × 35. (After Odhner, 1902, fig. 2.)

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[a] Synonyms.—*Distoma buskii* Lankester, 1857; *Dicrocœlium buskii* (Lankester) Weinland, 1858; *Distoma crassum* Cobbold, 1860 (not von Siebold, 1837); *Distomum crassum* (Cobbold) Leuckart, 1863; "*Distomum hepaticum*" of Leidy, 1873, p. 364; *Distoma buski* Blanchard, 1888; *Dicrocœlium buski* Blanchard 1888; "*Distoma* (*Dicrocœlium*) *buski*" of Railliet, 1893; *Distomum buski* (Blanchard) Braun, 1895; *Distoma cranum* Huber, 1896 (misprint); *Fasciolopsis buskii* (Lankester) Stiles, 1901; *Fasciolopsis buski* (Blanchard) Odhner, 1902; *Fasciolopis buski* (Blanchard) Odhner, 1902.

Bibliography.—Cobbold, 1879, pp. 20–29. For more recent technical discussion with historical review, see Odhner, 1902, pp. 573–581.

more attenuate anteriorly than posteriorly, ventral surface flat, dorsal surface slightly convex, margins very thin. Oral sucker ventro-subterminal, small, 0.5 mm. in diameter, 0.33 mm. deep. Ventral acetabulum 1.6 to 2 mm. in diameter, but elongated caudally directly under the ventral surface in a 2 to 8 mm. long sack; center of acetabulum 1.8 to 2 mm. from anterior end of body. Skin without spines. Prepharynx 0.28 mm. long; pharynx 0.7 mm.; esophagus very short so that the bifurcation of the intestine occurs about on anterior plane of acetabulum; ceca with two characteristic curves toward median line, one at equator, the other between the testicles. *Male organs.*—Cirrus pouch cylindrical, median, nearly one-fourth as long as the body, 0.25 to 0.33 mm. thick, straight, extending from genital pore to about midway to shell gland (equator); it contains a long sinuous vesicula seminalis with a long blind sack possessing lateral branches, this sack reaching from a short distance caudad of acetabulum to about 0.5 mm. from caudal end of pouch; pars prostatica 0.5 mm. long, ductus ejaculatorius rather short, provided with fine spines; vasa defferentia near median line; testicles one posterior of the other; branches of posterior testicle extend to within about 3 mm. of the caudal end of the body. *Female organs:* Vitelline reservoir rather small; shell gland 1 to 1.5 mm. in diameter. *Eggs* numerous, 120 to 130 μ long by 77 to 80 μ broad. Sporocyst, redia, cercaria, and intermediate host undetermined.

Habitat. Small intestine of man (*Homo sapiens*); Asia.

This parasite has been reported several times for man, all the cases being of Asiatic origin. Judging from the writings of Dobson (1893a, 1893b) and Giles (1892, 1893) this parasite is probably more common, especially in India, than is generally supposed.

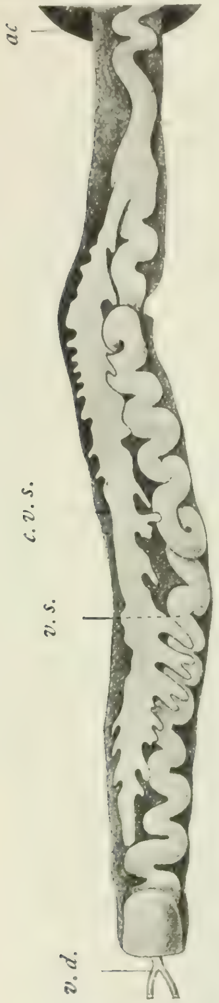

Fig. 66.—Dorsal view of that portion of the cirrus pouch which lies caudally of the acetabulum: *ac.*, acetabulum; *c. v. s.*, cul-de-sac of the vesicula seminalis; *v. d.*, vas deferens; *v. s.*, vesicula seminalis. (After Odhner, 1902, fig. 3.)

Rathouis's Intestinal Fluke—FASCIOLOPSIS RATHOUISI[a] (Poirier, 1887) Ward, 1903.

[Fig. 67.]

Specific diagnosis.—*Fasciolopsis:* 25 mm. long, 16 mm. broad; whitish, tinted with brown on the margins; oblong oval, obtuse, anterior end appears to be provided with a more or less distinct short cephalic cone, 3 to 5 mm. broad. Oral sucker (?) subterminal, very small, its opening not over 0.5 mm. in diameter (after Moniez), or 1.5 mm. (after Braun). Ventral acetabulum much larger, situated about 2 mm. from the oral sucker, its circular orifice 2 mm. in diameter. Skin without spines. Prepharynx (?); pharynx (?); esophagus (?); intestinal ceca (?). *Male organs:* Cirrus pouch (?) (apparently long); vasa deferentia apparently rather divergent; testicles side by side. *Female organs:* Ovary caudad of transverse vitello-duct. *Eggs* ovoid, 150 μ long by 80 μ broad. Sporocyst, redia, cercaria, and intermediate host undetermined.

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[a] Synonyms. *Distomum rathouisi* Poirier, 1887; *Distoma rathouisii* Huber, 1894 (misprint); *Fasciolopsis rathouisi* (Poirier) Ward, 1903.

HABITAT.—Intestine or (?) gall ducts of man (*Homo sapiens*); Asia.

The original description by Poirier (1887) is not accessible to me. Most authors consider this species identical with *Fasciolopsis buskii*, but Moniez (1896) has questioned their identity and Odhner's (1902) recent work seems to prove that the two forms are distinct.

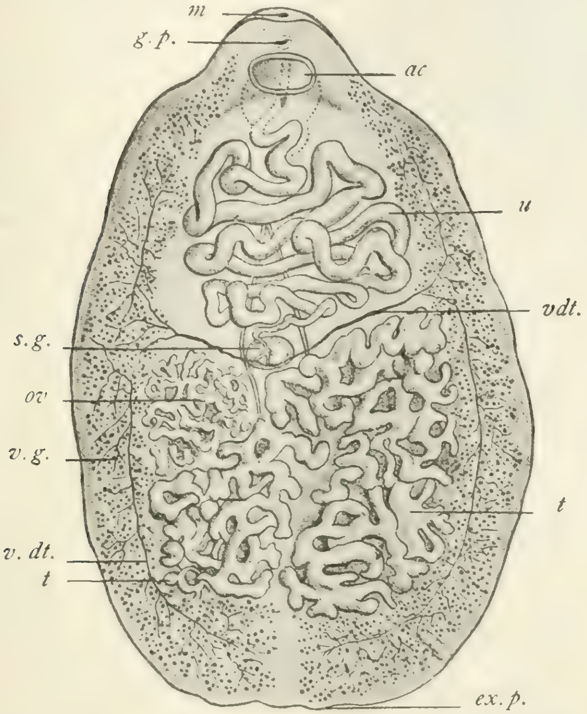

FIG. 67.—Ventral view of *Fasciolopsis rathouisi*, enlarged to show the anatomy: *ac.*, acetabulum; *ex. p.*, excretory pore; *g. p.*, genital pore; *m.*, mouth with oral sucker; *ov.*, ovary; *s. g.*, shell gland; *t.*, testicle; *u.*, uterus; *v. g.*, vitellogene gland; *vdt.*, vitelloduct. (After Poirier, 1887 [from Railliet, 1893, p. 365, fig. 243].)

Genus HETEROPHYES[a] Cobbold, 1866.

GENERIC DIAGNOSIS.—Fasciolidae:[b] Body small, contractile neck not very sharply defined from body; anterior end more contractile; posterior end more or less bluntly rounded, plump, and less motile. Skin thickly beset with scale-like spines, except for a small area at aboral pole. Oral sucker without thorns; ventral acetabulum situated at the border between the anterior more contractile, and aboral plumper, less contractile portion of body, and is considerably larger than oral sucker. Intestine with pharynx closely following the oral sucker; esophagus moderately long; intestinal ceca simple, extending to extreme aboral end of body. *Genital pore* posterolateral of and in immediate vicinity of ventral acetabulum; it is surrounded by a muscular ring (*genital ring*), the outer free margin of which is provided with a not quite complete wreath of bent chitinous rods with lateral branches. True copulatory organs absent; male and female genital tubes unite before reaching the pore, thus forming a genital cloaca. *Male organs:* Testicles oval, in extreme aboral end of body, on same transverse plane, their longitudinal axis nearly at right angles to the longitudinal axis of the body; vesicula seminalis flexed, anterior end of latter forming a pars prostatica, both lying free in the parenchyma. *Female organs:* Ovary globular, median, or lateral, anterior of testicles; receptaculum seminis as large as ovary and building a sac-like evagination of Laurer's canal; vitellaria but slightly developed, situated on the margins of the posterior division of the body. Uterine coils not numerous; they extend laterally nearly to the aboral end, never posterior of the testicles, and not anterior of the ventral acetabulum. *Eggs* not numerous, with dark colored thick shell, 20 to 30 μ by 10 to 17 μ.

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[a] SYNONYMS.—*Heterophyes* Cobbold, 1866 (probably earlier); *Cotylogonimus* Lühe, 1899; *Cœnogonimus* Looss, 1899.

[b] This generic diagnosis includes some characters which in reality belong to the diagnosis of the subfamily.

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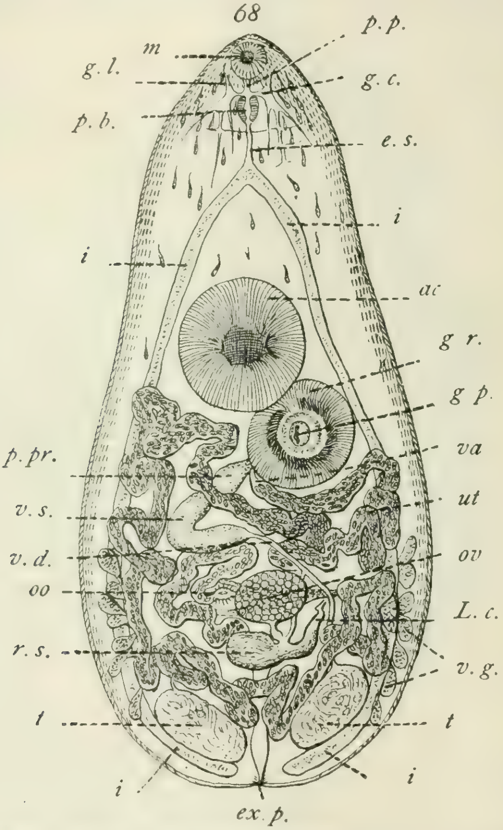

FIG. 68.—Ventral view of *Heterophyes heterophyes*, enlarged to show the anatomy: *ac.*, acetabulum; *es.*, esophagus; *ex. p.*, excretory pore; *g. c.*, cerebral ganglion; *gl.*, glands; *g. p.*, genital pore; *g. r.*, genital ring; *i.*, intestinal ceca; *L. c.*, Laurer's canal; *m.*, mouth with oral sucker; *oo.*, ootyp; *ov.*, ovary; *p. b.*, pharyngeal bulb; *p. p.*, prepharynx; *p. pr.*, pars prostatica; *r. s.*, receptaculum seminis; *t.*, testicle; *ut.*, uterus; *va.*, vagina (metraterm); *v. d.*, vas deferens; *v. g.*, vitellogene glands; *v. s.*, vesicula seminalis; *v. t.*, vitelloduct. (After Looss, 1894, fig. 1.)

HABITAT.—Intestine of mammals and birds.

TYPE SPECIES.—*Heterophyes heterophyes* (*Siebold, 1853*) Stiles, 1901.

The Egyptian Intestinal Fluke—HETEROPHYES HETEROPHYES[a] (Siebold, 1852), Stiles, 1901—of Man, Dogs, and Cats.

[Figs. 68 to 71.]

SPECIFIC DIAGNOSIS.—*Heterophyes:* 1 to 1.7 mm. long, 0.3 to 0.7 mm. broad; reddish, elongate, oval. Scales quadrate, 5 to 6 μ long by 4 μ broad; distal margin serrate with 6 to 9 points. Oral sucker 0.09 mm. in diameter, terminal to subterminal, about one-third as large as ventral acetabulum (0.23 mm.), which is in about the middle of the body; genital ring 0.15 mm. Prepharynx short, may attain 80 μ in length; pharynx 50 to 70 μ long, 40 to 50 μ in diameter; esophagus extends to a point about midway between the oral pole and the center of the acetabulum. Intestinal ceca thin, extending posteriorly and ending at the excretory bladder. The lateral ends of the vitellaria extend beyond the intestinal ceca, and some follicles extend ventrally. *Eggs* light brown, thick-shelled, oval, 20 to 30 μ by 15 to 17 μ, contain ciliated embryo when oviposited. Sporocyst, redia, cercaria, and intermediate host undetermined.

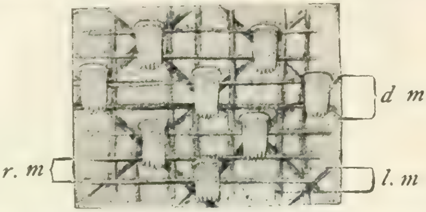

FIG. 69.—A portion of the skin, showing the peculiar quadrate spines, the (*dm.*) diagonal muscles, the (*lm.*) longitudinal muscles, and the (*rm.*) ring or circular muscles. × 1060. (After Looss, 1894, pl. 2, fig. 9.)

HABITAT.—Small intestine of man (*Homo sapiens*), dogs (*Canis familiaris*), cats (*Felis domestica*), and (?) fox (———).

GEOGRAPHIC DISTRIBUTION.—Egypt, Japan.

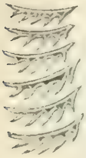

FIG. 70.—Chitinous rods of genital ring. × 700. (After Looss, 1894, pl. 1, fig. 5.)

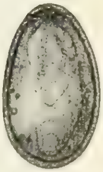

FIG. 71.—Mature egg of *Heterophyes heterophyes*, containing the fully developed embryo. Note the operculum at one pole. × 700. (After Looss, 1894, pl. 2, fig. 12.)

Family PARAMPHISTOMIDÆ.

Genus GASTRODISCUS Leuckart, 1877.

GENERIC DIAGNOSIS.—Paramphistomidæ, Cladorchinæ (Ventral acetabulum at poserior end. Two pharyngeal pockets present, testicles branched, vas deferens without pars maculosa, cirrus pouch present): Body divided into an anterior rather slender conical portion, and a posterior flattened ventrally concave disk, acetabulum small, ventral.

TYPE SPECIES.—*Gastrodiscus polymastos* Leuckart, 1877.

According to the recent revision of the amphistomes published by Fischœder (1902), the amphistome reported for man belongs to the genus *Gastrodiscus*. Stages of the life cycle of the Conical Amphistome (*Paramphistomum cervi*) are here introduced (figs. 79 to 83) to illustrate the biology of this group.

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[a] SYNONYMS.—*Distomum heterophyes* von Siebold, 1852; *Dicrocœlium heterophyes* (Siebold) Weinland, 1858; *Distoma heterophyes* (Siebold) Cobbold, 1860; *Heterophyes ægyptiaca* Cobbold, 1866 (probably earlier); *Mesogonimus heterophyes* (Siebold) Railliet, 1890; *Cœnogonimus heterophyes* (Siebold) Looss, 1899; *Cotylogonimus heterophyes* (Siebold) Braun, 1901.

BIBLIOGRAPHY.—For detailed anatomical discussion see Looss (1894, pp. 1–42, pl. 1, figs. 1–8; pl. 2, figs. 9–12).

The Asiatic Amphistome—GASTRODISCUS HOMINIS[a] (Lewis & McConnell, 1876) Fischœder, 1901—of Man.

[Figs. 72 to 78.]

Specific diagnosis.—*Gastrodiscus:* 5 to 8 mm. long, 3 to 4 mm. broad; reddish in color (fresh specimen). *Genital pore* about in middle of the anterior portion at bifurcation of the intestine. Testicles 2, lobate; vas deferens very sinuous. Disk without papillæ. *Eggs* oval, 150 μ by 72 μ with operculum.

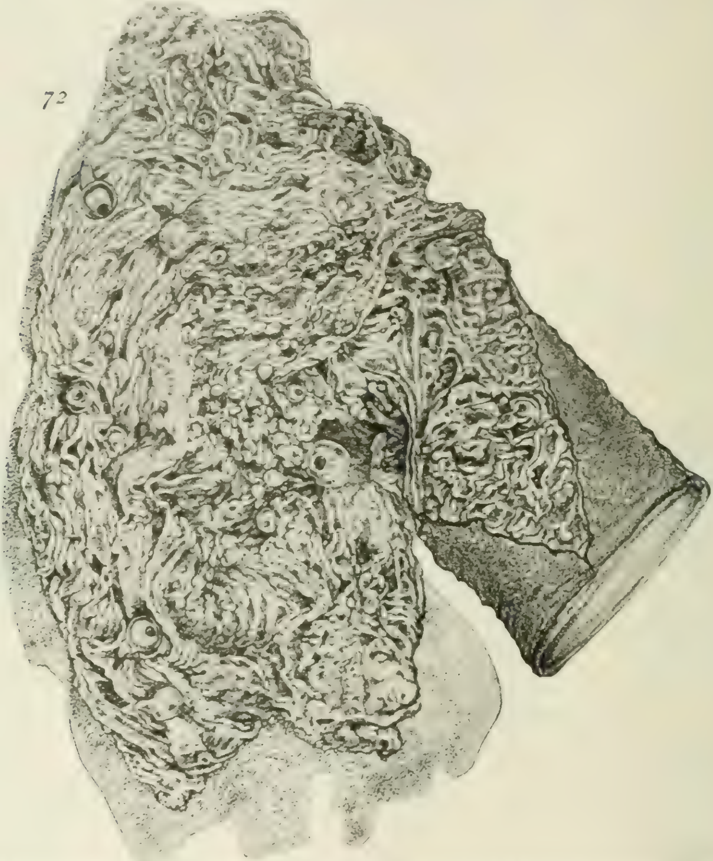

Fig. 72.—A portion of human intestine slit open, with specimens of *Gastrodiscus hominis*. Natural size. (After Lewis & McConnell, 1876, pl. 3, fig. 1.)

Habitat.—Cecum and colon of man (*Homo sapiens*).

Geographic distribution.—Asia.

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[a] Synonyms.—*Amphistoma hominis* Lewis & McConnell, 1876; *Amphistomum hominis* (Lewis & McConnell) Davaine, 1877; *Gastrodiscus hominis* (Lewis & McConnell) Fischœder, 1901.

Bibliography.—For the cases thus far reported see Lewis & McConnell (1876, pp. 182-186), Dobson (1893*a*, 1893*b*), and Giles (1892, 1893). Judging from the writings of Dobson and Giles, this parasite seems to be much more common in India than is generally supposed.

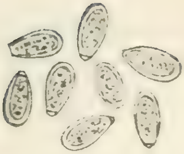

FIG. 73.—Ventral view of *Gastrodiscus hominis*, showing oral sucker, genital pore, sucking disk, and acetabulum. ×2. (After Lewis & McConnell, 1876, pl. 3, fig. 2a.)

FIG. 74.—Dorsal view of same. ×2. (After Lewis & McConnell, 1876, pl. 3, fig. 2b.)

FIG. 75.—The same. ×2. (After Lewis & McConnell, 1876, pl. 3, fig. 2c.)

FIG. 76.—Lateral view of same. ×2. (After Lewis & McConnell, 1876, pl. 3, fig. 2d.)

FIG. 77.—Eggs of *Gastrodiscus hominis.* ×65. (After Lewis & McConnell, 1876, pl. 3.)

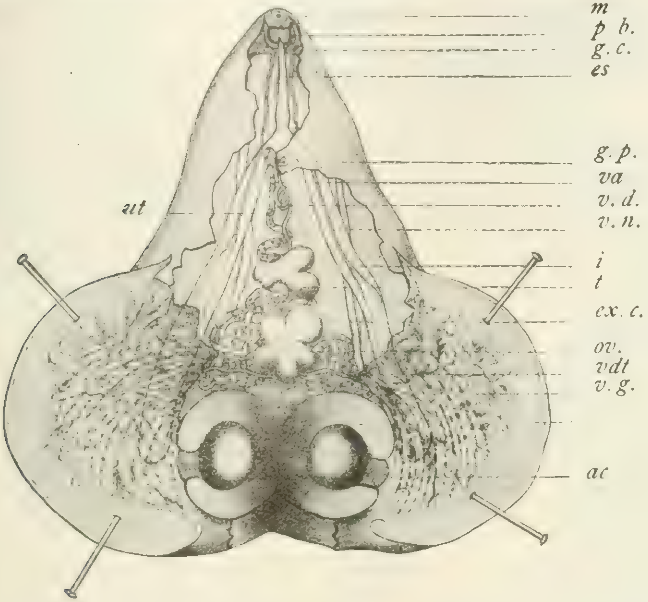

FIG. 78.—*Gastrodiscus hominis*, partially dissected to show the anatomy: *ac.*, acetabulum; *es.*, esophagus; *ex. c.*, excretory canal; *g. c.*, cerebral ganglion; *g. p.*, genital pore; *i*, intestinal ceca; *m.*, mouth with oral sucker; *ov.*, ovary; *p. b.*, pharyngeal bulb; *t.*, testicle; *ut.*, uterus, with eggs; *va.*, vagina (metraterm); *v. d.*, vas deferens; *v. dt.*, vitelloduct; *v. g.*, vitellogene gland; *v. n.*, ventral nerve. ×12. (After Lewis & McConnell, 1876, p. 185.)

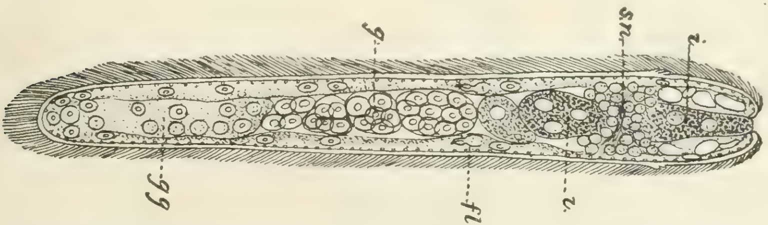

FIG. 79.—Dorsal view of the free embryo (miracidium) of the Conical Amphistome (*Paramphistomum cervi*) about to enter the intermediate host: *fl.*, end portion of excretory system; *g.*, germ cells; *gg.*, matrix of germ cells; *i.*, rudimentary intestine; *sn.*, nervous system. ×285. (After Looss, 1896, pl. 12, fig. 125.)

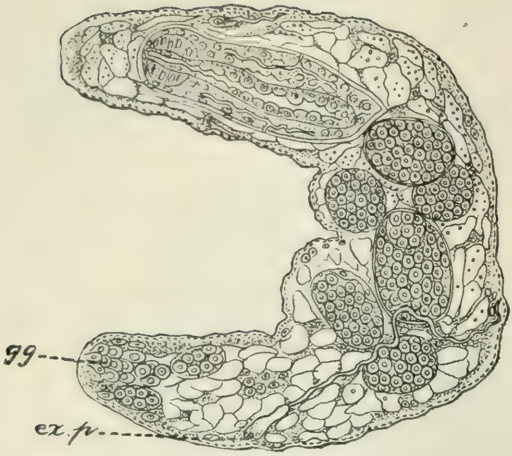

FIG. 80.—Sporocyst of the Conical Amphistome resulting from the transformation and development of the embryo, age about fifteen days: *ex.p.*, excretory pore; *gg.*, matrix of germ cells. The large balls of cells represent developing rediæ of the next generation. ×170. (After Looss, 1896, pl. 12, fig. 126.)

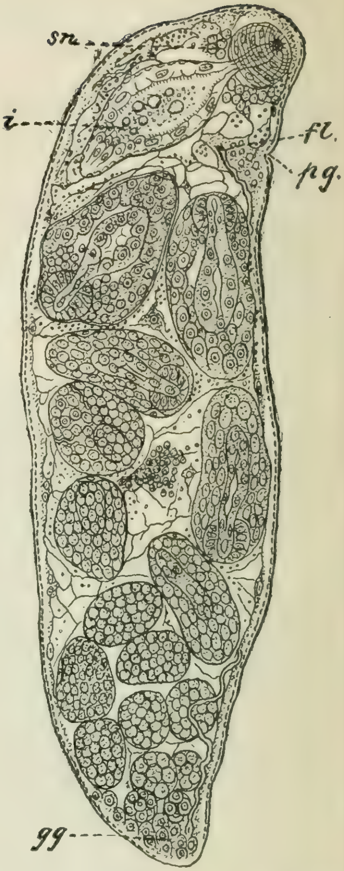

FIG. 81.—Adult redia of the Conical Amphistome (*Paramphistomum cervi*) of the first generation, thirty-nine days after the infection of the intermediate host with embryos: *fl.*, end portion of excretory system; *gg.*, matrix of germ cells; *i.*, rudimentary intestine; *pg.*, birth opening; *sn.*, nervous system. (After Looss, 1896, pl. 12, fig. 129.)

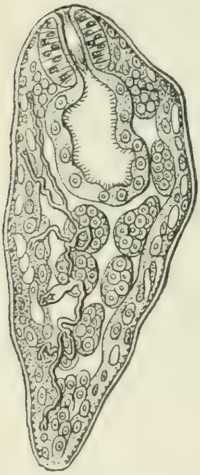

FIG. 82.—Young redia of the Conical Amphistome of the second generation in which the cercariæ develop. ×170. (After Looss, 1896, pl. 12, fig. 130.)

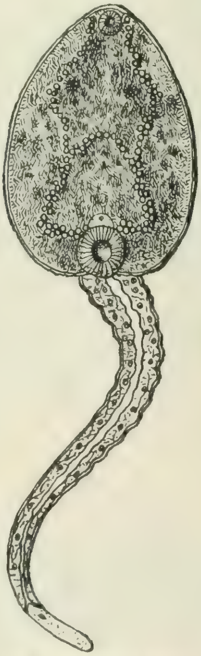

FIG. 83.—Mature cercaria of the Conical Amphistome (*Paramphistoma cervi*), the stage which gains access to cattle and sheep. ×75. (After Looss, 1896, pl. 12, fig. 133.)

VENAL DISTOMATOSIS.

Venal distomatosis is known as bilharziosis, or Egyptian hematuria. It is caused by flukes of the genus *Schistosoma*. As a matter of fact, the flukes themselves seem to be comparatively harmless; it is their sharp-pointed eggs which do the injury. At least three (imported) cases have been diagnosed in the United States, and the disease is said to exist in Cuba and Porto Rico.

Clinical diagnosis.—Make microscopic (low power) examination of fresh urine and feces to find the characteristic eggs or embryos; examine particularly the flocculi and clots found in the urine. In doubtful cases, have patient micturate and examine the last few drops forced out by straining.

Symptoms. If ova are confined chiefly to urogenital system: Hematuria, pains in lumbar region, left iliac fossa, thigh, or vulva, either spontaneous or at micturition; cystitis, vesical calculus, urinary fistulæ, vaginal tumors, nephritis. If ova are confined chiefly to rectum: Bloody stools, diarrhea, prolaps of rectum, papilliform growth which may require surgical interference.

Treatment.—Favorable results are claimed from repeated doses of male fern; some authors consider specific treatment futile; practically, treatment is the same as for chronic cystitis; occasionally surgical interference for polypoid growths.

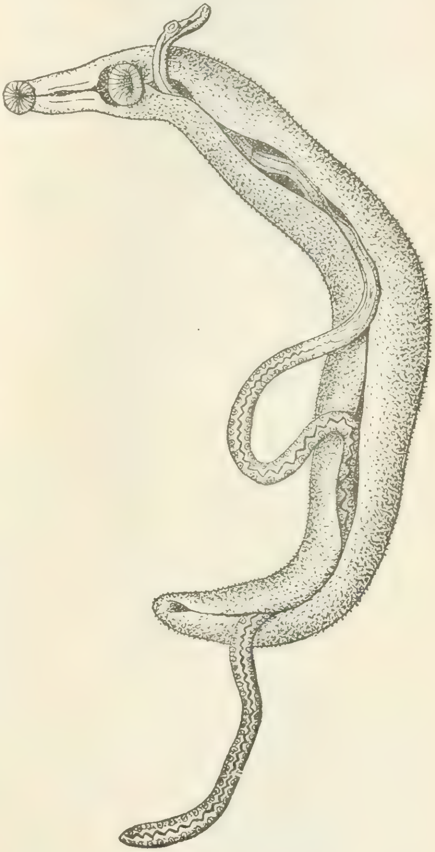

Fig. 84.—Male and female specimens of the Human Blood Fluke (*Schistosoma hæmatobium*), enlarged. 12. (After Looss, 1896, pl. 11, fig. 107.)

Family SCHISTOSOMIDÆ.

Genus SCHISTOSOMA[a] Weinland, 1858.

Generic diagnosis.—Schistosomidæ (sexes separate): *Male:* Broad with ventrally curved lateral margins, forming the canalis gynæcophorus. Intestinal ceca unite some distance caudad of the acetabulum. *Genital pore* median, caudad of acetabulum. Copulatory organs absent; genital glands confined to a small area at the anterior end of canalis gynæcophorus; testicles composed of about five divisions; vesicula seminalis small, pars prostatica not evident. *Female:* Filiform. Uterus very long; may contain numerous eggs, with terminal or subterminal spine.

Habitat.—Veins of mammals.

Type species.—*Schistosoma hæmatobium* (Bilharz, 1852).

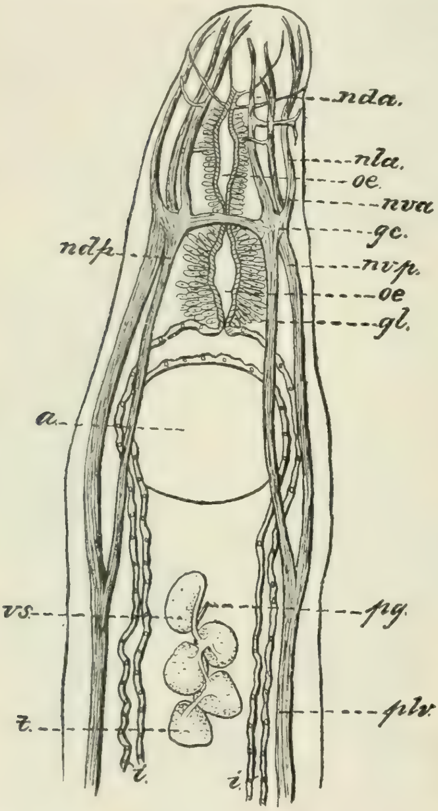

Fig. 85. Anterior portion of male Human Blood Fluke (*Schistosoma hæmatobium*), showing the anatomical characters: *ac.*, acetabulum; *gc.*, cerebral ganglion; *gl.*, glands of esophagus (*oe.*); *i.*, intestine; *nda.*, dorsal anterior nerve; *ndp.*, dorsal posterior nerve; *nla.*, lateral anterior nerve; *nva.*, ventral anterior nerve; *nvp.*, ventral posterior nerve; *plr.*, lateral posterior nerve; *gp.*, genital pore; *t.*, testicles; *vs.*, vesicula seminalis. (After Looss, 1895, pl. 2, fig. 18.)

The Human Blood Fluke—SCHISTOSOMA HÆMATOBIUM[b] (Bilharz, 1852) Weinland, 1858.

[Figs. 84 to 88.]

Specific diagnosis.—*Schistosoma. Male:* Whitish, 4 to 15 mm. long, 1 mm. broad; anterior portion of body 0.6 mm. long. Oral sucker about same size as acetabulum, which is anterior, immediately caudad of bifurcation of intestine. Skin with numerous small warts. Esophagus short; intestinal ceca reunite caudad of testicles; caudally of acetabulum, 4 to 6 glandular testicular bulbs. *Female:* Whitish to dark red brown, 15 to 20 mm. long. Suckers as in male. Skin with minute spines. Intestine as in male,

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[a] Synonyms. — *Schistosoma* Weinland, 1858; *Gynæcophorus* Diesing, 1858; *Bilharzia* Cobbold, 1859; *Thecosoma* Moquin-Tandon, 1860; *Schistosomum* R. Blanchard, 1895.

[b] Synonyms. — *Distomum hæmatobium* Bilharz, 1852; *Schistosoma hæmatobium* (Bilharz) Weinland, 1858; *Gynæcophorus hæmatobius* (Bilharz) Diesing, 1858; *Bilharzia hæmatobia* (Bilharz) Cobbold, 1859; (?) *Bilharzia magna* Cobbold, 1859; *Thecosoma hæmatobium* (Bilharz) Moquin-Tandon, 1860; *Distoma capense* Harley, 1864, nomen nudum; *Bilharzia capensis* Harley, 1864; *Bilharzia hæmatobia hominis* Kowalewski, 1895; (?) *Bilharzia hæmatobia magna* (Cobbold) Kowalewski, 1895; *Schistosomum hæmatobium* (Bilharz) Blanchard, 1895.

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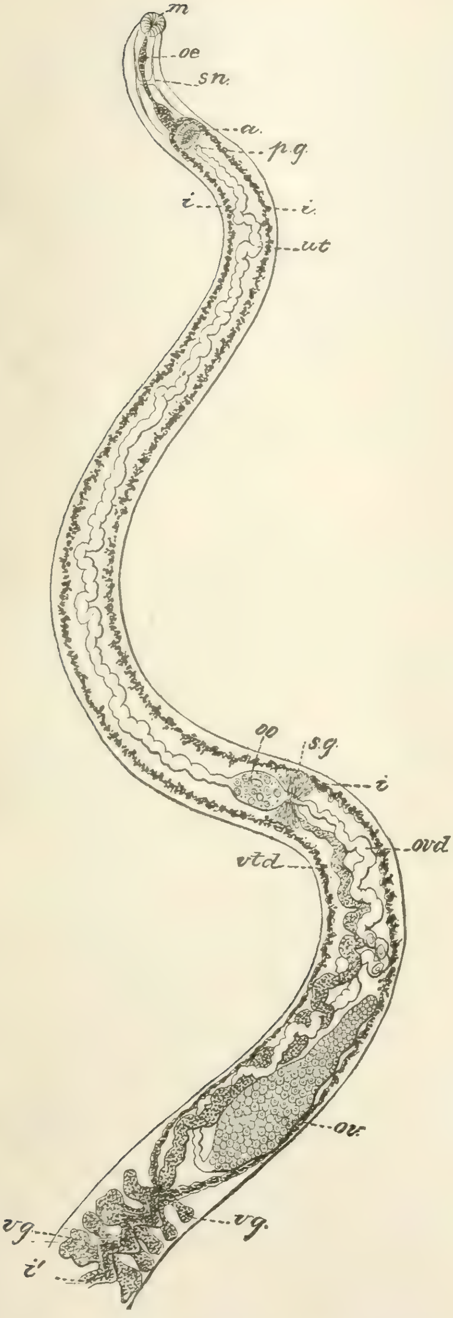

FIG. 86.—Anterior portion of female Human Blood Fluke (*Schistosoma hæmatobium*), showing the anatomic characters: *a*, acetabulum; *es.*, esophagus; *gp*, genital pore; *i.*, intestine, which is double for some distance, but the two ceca unite (*i*) back of the ovary; *oo.*, ootype; *ov.*, ovary; *ovd.*, oviduct; *sg.*, shell gland; *sn.*, nervous system; *ut.*, uterus; *vtd.*, vitelloduct; *vg.*, vitellogene glands. × 38. (After Looss, 1896, pl. 11, fig. 108.)

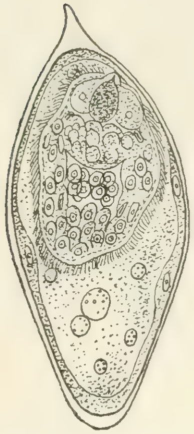

FIG. 87.—Egg of Human Blood Fluke (*Schistosoma hæmatobium*), with contained embryo, passed in the urine. × 285. (After Looss, 1896, pl. 11, fig. 112.)

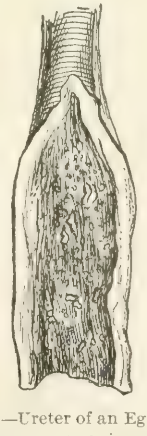

FIG. 88.—Ureter of an Egyptian, with numerous uric-acid concretions, as a result of blood-fluke infection. (After Leuckart, 1894, p. 528, fig. 231.)

but the ceca reunite caudally of, but near the ovary. Uterus rather straight, ends posteriorly in a bulb-like ootype, immediately posterior of which the shell gland, oviduct, and vitelloducts come together; ovary sacular, elongate; vitellaria extend from near the caudal end of the ovary to the caudal end of the body, and are provided with lateral acini. *Eggs* oval, 135 to 160 μ long by 55 to 66 μ broad; without operculum, but usually with terminal or subterminal spine; develop ciliated embryo in tissue after oviposition.

HABITAT.—Veins of man (*Homo sapiens*) and certain monkeys.

GEOGRAPHIC DISTRIBUTION.—Chiefly in Africa; sporadic imported cases in other countries.

WASHINGTON, D. C., *August, 1903.*

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The following bibliography, prepared from my manuscript by my assistant, E. C. Stevenson, contains only the more general articles and the works which will enable the reader to trace the literature on the parasites in question. The abbreviations used are those adopted in the Index-Catalogue of Medical and Veterinary Zoology. W^a signifies that the work may be consulted in the library of the United States Department of Agriculture; W^m, in the library of the Surgeon-General, United States Army; Lib. Stiles, in private library of C. W. Stiles, at Hygienic Laboratory, U. S. Public Health and Marine-Hospital Service.

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